bart
impact
program

Land Use and Urban Development Project

STUDY OF BART'S EFFECTS ON PROPERTY PRICES AND RENTS

Local transit -- CA - SF metro area
BART - Eco. asp.
Real prop. --Prices -- CA -- SF metro area
Rent " " "

[redacted]

The BART Impact Program is a comprehensive, policy-oriented study and evaluation of the impacts of the San Francisco Bay Area's new rapid transit system (BART).

The program is being conducted by the Metropolitan Transportation Commission, a nine-county regional agency established by state law in 1970.

The program is financed by the U. S. Department of Transportation, the U. S. Department of Housing and Urban Development, and the California Department of Transportation. Management of the Federally funded portion of the program is vested in the U. S. Department of Transportation.

The BART Impact Program covers the entire range of potential rapid transit impacts, including impacts on traffic flow, travel behavior, land use and urban development, the environment, the regional economy, social institutions and life styles, and public policy. The incidence of these impacts on population groups, local areas, and economic sectors will be measured and analyzed. Finally, the findings will be interpreted with regard to their implications for the planning of transportation and urban development in the Bay Area and other metropolitan areas.

DOCUMENT NO. DOT-BIP-WP-52-5-78 DOT-OS-30176

BART IMPACT PROGRAM

LAND USE AND URBAN DEVELOPMENT PROJECT

STUDY OF BART'S EFFECTS ON PROPERTY PRICES AND RENTS

July 1978

(Revised November 1978)

WORKING PAPER

PREPARED FOR

U.S. DEPARTMENT OF TRANSPORTATION

AND

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

NOTICE

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A JOINT VENTURE

UNDER CONTRACT WITH THE METROPOLITAN TRANSPORTATION COMMISSION
FOR THE U.S. DEPARTMENT OF TRANSPORTATION
AND THE U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
UNDER CONTRACT DOT-OS-30176, TASK ORDER 205

JULY 1978

(REVISED NOVEMBER 1978)

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT-BIP-WP-52-5-78		

4. Title and Subtitle	5. Report Date
BART's Effects on Property Prices and Rents	July 1978
	6. Performing Organization Code
7. Author(s) Caj O. Falcke	8. Performing Organization Report No. WP-52-5-78
9. Performing Organization Name and Address John Blayney Associates/David M. Dornbusch & Co., Inc. A Joint Venture 1736 Stockton Street, San Francisco, California 94133 For Metropolitan Transportation Commission	10. Work Unit No. (TRAIS) Task Order 205 11. Contract or Grant No. DOT-OS-30176
12. Sponsoring Agency Name and Address U.S. Department of Transportation and U.S. Department of Housing and Urban Development Washington, D.C.	13. Type of Report and Period Covered Working Paper 14. Sponsoring Agency Code

15. Supplementary Notes

The Metropolitan Transportation Commission is the prime contractor for the BART Impact Program. John Blayney Associates/David M. Dornbusch & Company, Inc., A Joint Venture, is the subcontractor responsible for the Land Use and Urban Development Project.

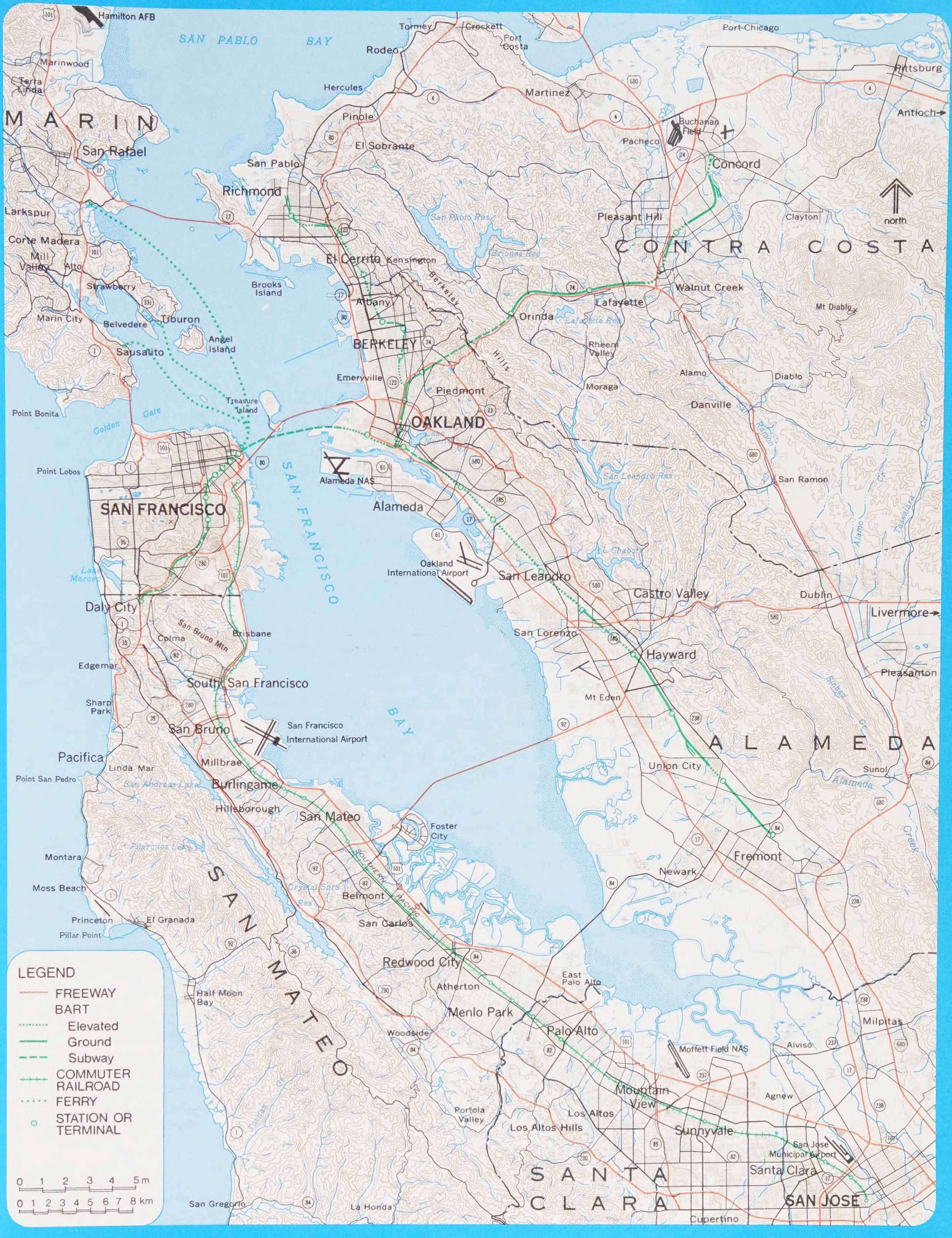
16. Abstract

This working paper addresses BART's effects on residential and commercial property prices and rents. Multiple regression analyses were carried out on eight study sites throughout the service area. The separate study site analyses were synthesized to derive observations applicable to more than one station area. At most sites, the data permitted separate analyses of pre-service (anticipatory) effects, immediate, and longer term (post-service) impacts. The study addresses specific issues of the timing of BART impacts as well as joint distribution effects. Information from key informants was used in specifying study areas, determining variables to be included in the models, and in corroborating analytical results.

17. Key Words	18. Distribution Statement
San Francisco Bay Area Rapid Transit System BART Impact Program Property Prices Rents	Document is available to the public through the National Technical Information Service, Springfield, Virginia 22151

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	129	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized



Metropolitan Transportation Commission

SAN FRANCISCO BAY REGION
CENTRAL AREA

BART: The Bay Area Rapid Transit System

Length: The 71-mile system includes 20 miles of subway, 24 miles on elevated structures and 27 miles at ground level. The subway sections are in San Francisco, Berkeley, downtown Oakland, the Berkeley Hills Tunnel and the Transbay Tube.

Stations: The 34 stations include 13 elevated, 14 subway and 7 at ground level. They are spaced at an average distance of 2.1 miles: stations in the downtowns are less than one-half mile apart, while those in suburban areas are two to four miles apart. Parking lots at 23 stations have a total of 20,200 spaces. There is a fee (25 cents) at only one of the parking lots. BART and local agencies provide bus service to all stations.

Trains: Trains are from 3 to 10 cars long. Each car is 70 feet long and has 72 seats. Top speed in normal operations is 70 mph with an average speed of 38 mph including station stops. All trains stop at all stations on the route.

Automation: Trains are automatically controlled by the central computer at BART headquarters. A train operator on board each train can override automatic controls in an emergency.

Magnetically encoded tickets with values up to $20 are issued by vending machines. Automated fare gates at each station compute the appropriate fare and deduct it from the ticket value.

Fares: Fares range from 25 cents to $1.45, depending upon trip length. Discount fares are available to the physically handicapped, children 12 and under, and persons 65 and over.

Service: BART serves the counties of Alameda, Contra Costa and San Francisco, which have a combined population of 2.4 million. The system was opened in five stages, from September 1972 to September 1974. The last section to open was the Transbay Tube linking Oakland and the East Bay with San Francisco and the West Bay.

Routes are identified by the terminal stations: Daly City in the West Bay, Richmond, Concord and Fremont in the East Bay. Trains operate from 6:00 a.m. to midnight on weekdays, every 12 minutes during the daytime on three routes: Concord-Daly City, Fremont-Daly City, Richmond-Fremont. This results in 6-minute train frequencies in San Francisco, downtown Oakland and the Fremont line where routes converge. In the evening, trains are dispatched every 20 minutes on only the Richmond-Fremont and Concord-Daly City routes. Service is provided on Saturdays from 9 a.m. to midnight at 15-minute intervals. Future service will include a Richmond-Daly City route and Sunday service.* Trains will operate every six minutes on all routes during the peak periods of travel.

Patronage: Approximately 146,000 one-way trips are made each day. Approximately 200,000 daily one-way trips are anticipated under full service conditions.

Cost: BART construction and equipment cost $1.6 billion, financed primarily from local funds: $942 million from bonds being repaid by the property and sales taxes in three counties, $176 million from toll revenues of transbay bridges, $315 million from federal grants and $186 million from interest earnings and other sources.

March 1978

*Sunday service began in July, 1978

PREFACE

The BART Impact Program (BIP) is a comprehensive policy-oriented effort to identify, describe, measure, and present findings as accurately as possible about the multi-faceted impacts of a major public transportation investment—the BART system. The major objective of the Land Use and Urban Development Project is to determine how and to what extent BART has influenced the spatial arrangements of people and activities within the San Francisco Bay Area. To accomplish this task, the project will focus on the way BART has influenced (1) location decision processes; (2) actual movement behavior that results from those decisions and other market forces; and (3) the form, character, and functioning of aggregate spatial groupings that represent the net outcome of those decisions and movement patterns. Changes attributable to BART will be measured against pre-BART and no-BART alternatives. In all of these studies BART's effects on individual socio-economic groups, particularly minorities and the disadvantaged, will receive careful attention.

The Land Use and Urban Development Project is one of six major projects comprising the BART Impact Program. The others are:

- Economics and Finance Project (E&F)
- Environment Project (Env)
- Institutions and Lifestyle Project (ILS)
- Public Policy Project (PP)
- Transportation System and Travel Behavior Project (TSTB)

Each of these projects is designed to investigate specific aspects of BART's impacts, to explain why the impacts occur, and to identify who is affected by the impacts and the distributional effects. The projects then will demonstrate how the information derived can be used by decision-makers to enhance the benefits and to reduce the dis-benefits of BART and to increase understanding of the potential impacts of rail rapid transit investments in the Bay Area and other American metropolitan areas.

This working paper presents the analysis and findings of the study of BART's effect on Property Prices and Rents—one aspect of BART's impacts on land use and urban development. The paper is presented for review by BART Impact Program staff, federal sponsors, and other interested planners and researchers.

ACKNOWLEDGEMENTS

Tom Schnetlage, assisted by Lisa Buchberg and Rod Stutt, performed most of the arduous data collection. Liisa Falcke did most of the distance measurements and deflating of prices and rents. Jane Ohlert, assisted by Kathy McCarthy, transformed the unreadable to readable.

Tory Gussman and Jim Merchant edited the report and made many helpful suggestions as to content and presentation. Jim Merchant and David M. Dornbusch were also instrumental in the interpretation of the statistical results and the theoretical discussions.

Mike Fajans of John Blayney Associates made many helpful suggestions during the course of the analysis. Michael V. Dyett, also of John Blayney Associates, insisted on the discussion of subject areas which might otherwise have been overlooked.

Michael A. Goldberg, Douglass B. Lee, Jr. and Eric Mohr, who reviewed an earlier draft of this report, made many particularly constructive comments which I have tried to incorporate here. Emilio Escudero, our contract officer from the Metropolitan Transportation Commission, gave his genuine support throughout the entire project.

To all of these, I express my appreciation for their diligent work. Thank you.

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SUMMARY AND FINDINGS

Objectives

The current study is part of the Land Use and Urban Development Project of the BART Impact Program. It seeks to determine the impacts of BART stations and tracks on property prices and rents and to further infer whether the price and rent changes might have had an influence on development patterns and population distributions in the San Francisco Bay Area.

Study Procedure

Altogether, twenty-seven multiple regression analyses were performed on changes in real (constant dollar) property prices and rents at seven sites encompassing twelve different BART stations. The price changes were studied over three time periods: from pre-BART to BART construction, from construction to post-BART, and from pre-BART to post-BART. Rents, which were not expected to reflect benefits many years in the future, were studied only over the period extending from just before service began to the present. The adopted regression model postulated BART's impacts as an inversely diminishing function of the distance from the station or the tracks. The model worked satisfactorily in all instances except for the Mission and 16th Street station area in San Francisco. The standard errors of the estimated models, as percentages of the mean changes in prices and rents, varied from four to thirty percent, but typically were only nine to eleven percent. The analytical results are, in light of key informant opinions and other independent information, credible.

Impacts on Residential Property Prices

The following general conclusions emerge from the study. Anticipated benefits from a location close to a BART station had a statistically significant, positive impact on single family residential prices except for one station area, El Cerrito Plaza. Since service began, this effect has generally disappeared, except for in South Hayward, and even turned negative where BART-related automobile traffic and parking has become a nuisance. In the aggregate, the effect has been small; the impact diminishes rapidly with increasing distance from BART and, in actuality, there are only rather few residential properties within the high-impact zone at most station areas. The expected negative effect of proximity to BART tracks (either elevated or at grade) is statistically insignificant and/or considerably smaller in magnitude than the positive effect of proximity to a station.

Impacts on Residential Rents

Neither positive nor negative effects were found on residential rents. However, there were some indications that this might be changing, at least in Walnut Creek where the positive effect of proximity to the station has become statistically

more stable and the negative effect of closeness to the tracks has all but disappeared. The sample here, however, is very small, making the above conclusion tentative, but worthy of follow-up research as more data can be accumulated.

Impacts on Office Rents

Proximity to a BART station has affected office rents in San Francisco, Oakland and Walnut Creek, although in Oakland it was only the upper range of rentals (the prestige offices) which was affected. The magnitude of the impact was largest in suburban Walnut Creek and smallest in San Francisco where it was marginal. In Walnut Creek the impact was noticeable only after BART trans-Bay service began.

Impacts on Commercial Property Prices

Because of lack of data, sales prices of commercial property were investigated only in the Mission District of San Francisco. There it was found that proximity to the BART stations had had a substantial impact early when it was anticipated that BART would bring an increase in customers near the stations (walk-in trade). Since these anticipations have largely failed to materialize, the reflection in commercial property prices has also disappeared.

Generalizable Impacts

Where impacts were discovered, their effects varied inversely with distance to either the station or the tracks. The impacts diminished rapidly with increased distance and all but disappeared beyond 4,000 or 5,000 feet from the stations. We did not encounter any factors which would have directly enhanced BART's positive effects on residential property, possibly because zoning or market restrictions in the station areas have often prevented development which would have taken specific advantage of BART amenities. Anticipated negative aspects, such as noise, had much less impact wherever BART made only a marginal addition to existing noise levels — for example, where BART runs parallel to an existing railroad track. However, the problems with overflowing parking and increased automobile traffic near station areas probably contribute substantially to negative impacts at certain suburban stations. Very similar results were obtained by the Environmental Impact Project.

In general, the analytical results were corroborated by available professional judgements and other studies regarding BART's effect on prices and rents.

Effect of BART-Related Taxes

Previous research has shown that the average real estate buyer does not capitalize future taxes in calculating the full purchase price. The current study has likewise failed to show such sophistication on the part of the transactors on the real estate market.

BART's impacts on prices and rents, where present, have been in dollar terms

rather small except for in the most advantageous locations. The Alameda County Assessor stated that his office has noticed no impact of BART on property prices and, consequently, no effect of a location vis-a-vis BART is reflected in assessments and hence property taxes.[1] On an aggregate level, however, BART may have raised areawide property prices and rents in certain locations, notably Walnut Creek and Glen Park. If so, BART has had a distributional effect in the Bay Area by allocating demand for higher priced housing to these areas.

Policy Implications

If increased property prices and rents — either as indicators of increased amenities or for the purposes of a value capture policy — were a specific objective of a rail transit system, the system's design would probably have to be somewhat different from that of BART. Notably, the current problems of overflowing parking and increased automobile traffic in some station areas would have to be solved — perhaps by eliminating the lots in favor of extensive feeder bus systems which operate as part of a normal local bus system (as in Europe) or clever design of compact (underground) parking structures. Zoning and other regulations would also have to encourage or at least allow development which can capitalize fully on BART amenities to take place. Typically this would mean higher densities and good use of air rights (over parking structures) fostering multi-use developments near the station areas. A paramount requirement for success is careful coordination between physical development, land use controls and the transportation improvement.

The property price and rent increases detected by this study are relatively so small that a value capture system to redeem the benefits created by the society back to the public would not be worth the effort. Value capture as a means of financing transit systems would have to be part of the initial design in order to reach proportions worth consideration.

The No-BART alternative might have caused increases in property prices and rents in areas with comparatively good bus transit access, but concentrations of changes, such as those detected here (around BART stations), would likely not have materialized.

Location Distribution

BART's effect on property prices, being slight, has not exercised any significant impact on residential location patterns. Likewise, office locations have probably not been affected. Although office rents were found to be positively influenced by proximity to a BART station, this has likely not repelled development but rather is a reflection of the added demand for such locations.

Distributional Effects

Theoretically, at least, BART induced relative shifts in property prices and rents

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1. There is, of course, the general BART-district tax assessed to all properties in the BART counties, regardless of their locations vis-a-vis BART.

among locations served and not served by BART. However, the actual price and rent changes have been so small relative to the recent substantial increases in property prices in the Bay Area in general that the possible BART-induced shift is obscured.

1. INTRODUCTION

A large public project, such as BART, affects the economic activities and well-being of households and enterprises.

Generally, the difficulty in determining the (dis)utility of such a public investment is that the entire output of the investment is not sold on the market where its value can be determined by conventional marginal analysis. The (dis)utility can, however, be evaluated by analyzing the implicit demand for the public investment: that is, by analyzing how people are indirectly spending their dollars to obtain the benefits, or avoid the nuisances, generated by the change.

Housing prices or rentals apply to a flow of services from a dwelling unit and its location. The quantity and quality of these services depend on the attributes of that unit. Housing prices and rentals which a consumer is willing to pay then depend on the particular set of attributes which define the unit. Thus, amenities and nuisances, such as proximity to BART, associated with the location of property are reflected in the market price for that property. Indeed, it has been shown that a theoretically meaningful and operationally feasible model expressing the relation between changes in property prices and locational attributes can be established.[2]

Whether or not real estate prices reflect full or net benefits, private or public utilities, or whether they over- or underestimate "true" benefits in the general case, is under considerable debate. However, under certain, not unrealistic conditions, the change in utility (productivity) associated with a public project equals the net change in the value of land directly affected by the project.[3] Property prices and rents are therefore important indicators of perceived BART benefits and disutilities.

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2. Among others, Caj O. Falcke, et al., The Impact of Water Quality Improvements on Residential Property Prices (San Francisco: David M. Dornbusch & Company, Inc., 1975); Robert C. Lind, "Spatial Equilibrium, The Theory of Rents, And the Measurement of Benefits from Public Programs," Quarterly Journal of Economics 87, May 1973; Douglass B. Lee, Jr., et al., Impacts of BART on Prices of Single Family Residences, BART Impact Studies Final Report Series (Berkeley: University of California, IURD, 1973); A. C. Anderson, "The Effect of Rapid Transit on Property Values," Appraisal Journal 38 (1970), pp. 59-68; David Boyce, et al., Impact of Rapid Transit on Suburban Residential Property Values and Land Development (Philadelphia: University of Pennsylvania, Regional Science Department, 1972); K. C. Koutsopolous, "The Impact of Mass Transit on Residential Property Values," Annals of the Association of American Geographers 67 (December, 1977); Edward I. Isidor, Modelling the Impact of Highway Improvements on the Value of Adjacent Land Parcels (doctoral dissertation, Purdue University, 1970); Michael A. Goldberg, "An Evaluation of the Interaction Between Urban Transport and Land Use Systems," Land Economics 48 (November, 1972), pp. 338-346.

3. Robert C. Lind, op. cit.

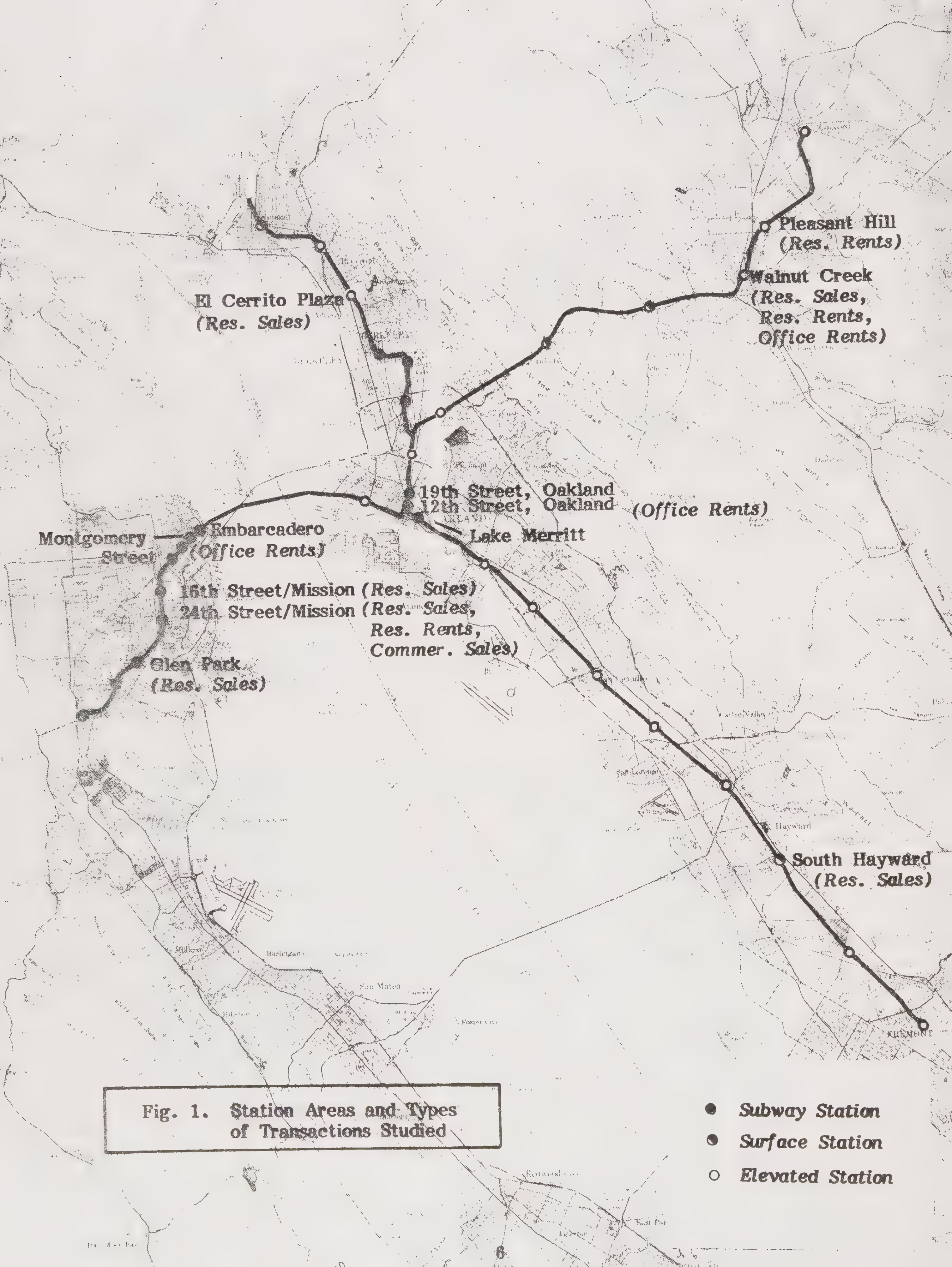

Fig. 1. Station Areas and Types of Transactions Studied

An Overview

Chapter 2 deals with theoretical and empirical research issues. The remainder of this chapter presents a discussion for the reader who prefers a less technical discussion of these topics.

The study seeks to determine BART's impact on residential and commercial property prices and rents, and associated locational effects in the Bay Area. A multiple regression model for isolating price and rent impacts which are either exclusively or jointly with other factors attributable to BART is specified and estimated for eight study sites encompassing altogether 12 BART stations. More than one type of transaction was studied at several of the study areas. Figure 1 (on the previous page) shows the location and type of transaction studied at each site.

To minimize the effect of inflation and other regionwide effects on the real estate markets, all prices and rents are expressed in constant, 1975 dollars. Note, however, that because of the lack of a proper office rent index, the changes in office rents are expressed in relation to the change in office construction cost. Thus, when the estimated models show a decline in office rents, it does not imply that BART has had a negative impact. The implication is that office rents overall have increased less than the corresponding construction costs. Thus, BART's impact appears as a lesser decrease in the vicinity of the stations.

For both theoretical and empirical reasons, the impact of BART is measured in terms of percentage changes in property prices and rents. The model assumes that more benefits, or nuisances, occur to those who are located closer to BART and postulates that the impacts diminish inversely with increasing distance from stations and tracks. The general form of the function is depicted in Figure 2.

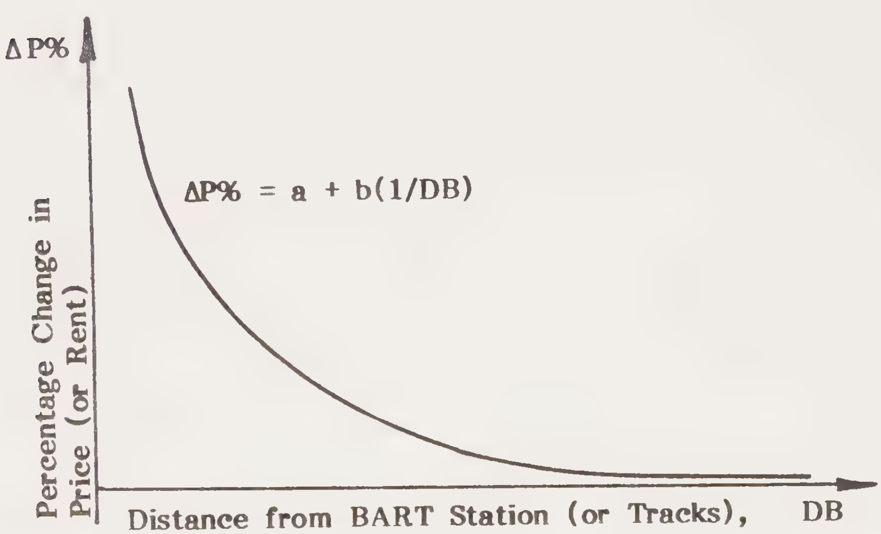

Fig. 2. General Form of the Relationship Between Changes in Property Prices and Rents, and BART

Distance in itself, of course, does not have an impact on residential or commercial values. It is factors associated with distance, such as accessibility and noise, which are of importance. Moreover, it is not necessarily the factual but the perceived magnitudes or levels of such variables which ultimately affect market transactions. Distance is therefore not only a convenient proxy for the actual determinants but it may even be a better variable (if it is more closely related to the perceived changes in the environment) than factual, physical units, such as decibles.

The study employs a "before/after" technique. Explanatory models are developed for changes in property prices before, during, and after BART's construction. The changes from the "before" to the "during" period are referred to as "anticipatory effects;" those from "during" to "after" are termed "immediate effects." The third pair analyzed, from the "before" to the "after" period, is called "longer term impact" although, in fact, BART has been in operation only a few years. Anticipation of the BART impact, however, already formed in the early or mid-Sixties. Rent levels do not anticipate changes very much and were studied only for the period immediately preceding BART service to the present.

Proximities to both BART stations and tracks are primary variables in the models. Other variables include characteristics of the site (e.g., parking, proximity to freeways, schools, and parks) and of the property itself (lot size, corner or busy street location, age and height of the buildings, tenancy). At each site, and depending upon the type of transaction under study, the basic model then varies with respect to the inclusion of non-BART variables assumed a priori to have influenced the change in prices and rents.

Some of the explanatory variables do not directly express changes. However, they may represent changes if the preferences associated with them have changed during the period of study. To illustrate, the importance of being within walking distance of a school may change with the availability or desirability of school busing, or the merit of a corner location may change with changing traffic volumes or patterns. These "stock" variables should therefore be seen as proxies for changing preferences which are much more difficult to observe and measure directly. The other variables in the model representing new characteristics in the environment, such as a new shopping center or school, represent genuine physical changes but may also contain elements of changed preferences. For example, the perceived value of a new park may well increase with growing urban congestion.

Characteristics of the parcel and the structures on it are included in the model to reflect the possibility that prices and rents may have changed differently for different property categories. For example, the more expensive properties may have appreciated in market value less than smaller properties. Or, the values of traditionally prime locations on Montgomery or California Streets in San Francisco may have declined relative to other locations in the downtown area.

Previous experience has shown that little can be gained by expressing the various distances in the model in terms of walking distance or time, as compared to straight-line distance. Since there is no appreciable gain in accuracy, expedience then argues for expressing all distances in the model as the shortest distance from the properties to the various influences on property prices.

The study procedure involved collecting price data mainly from the assessors'

offices in San Francisco and Contra Costa Counties.[4] The Alameda County Assessor, Mr. Hutchinson, did not agree to cooperate in our data collection efforts so the information for the South Hayward study site had to be obtained from Multiple Listing sources. Unfortunately, these listings do not go further back in time than 1969 so an analysis of anticipatory effects could not be undertaken for this site. The information on residential and office rents came from private real estate companies, leasing agents and building managers. The data collection effort is described in detail in Appendix C.

The analysis of price changes of commercial property, especially large office buildings, was complicated by two problems. First, there were not very many sales of commercial properties which met the study's time period and other requirements. Second, the sale price of a commercial property often reflects many determinants other than those directly related to the property itself. It was, therefore, possible to conduct only a rent/lease analysis for this segment of the market, except for the Mission District in San Francisco where there has been a sufficient turnover of small, but mixed, commercial property. Rents and leases, however, ought to reflect real estate values at least as well as prices, and in the case of commercial property, probably even better than prices due to the above-mentioned reflection of other factors in the commercial building prices.

In econometric research, the final test of significance consists of deductions and cross-checks where theory and prior research, professional knowledge of the phenomenon under study, and appropriate statistical techniques all concur. Thus, the study procedure also utilized key informants in specifying study areas, determining variables to be included in the models, and in corroborating the analytical results.

The limitations of the analysis are more empirical than conceptual. Multicollinearity, for example, is a situation where two or more of the explanatory variables happen to be covariant, thus making it impossible or difficult to disentangle their separate effects. An example best clarifies this. Suppose that the study area extends from the BART station nearly perpendicular to the BART tracks. In that case, any given property in the study area is nearly equidistant to both the station and the tracks. Consequently, the station and the tracks are covariant and their respective effects cannot be separated, at least not on the basis of distance. Suppose instead that the study area parallels the direction of the tracks. In this case, most properties would possess a unique combination of distances to the station and the tracks. Consequently, the separate station and track impacts could be identified.

Excluding a covariant variable from the model would not solve the problem. The estimated coefficients of the included, covariant variables would still retain

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4. In a few instances where the recorded sale price obviously did not reflect a true market price or included substantial improvements in the property, the sale price S_j was substituted for by kA_j, where A_j is the assessed value for property j and k is the average ratio of sales prices to assessed values for the area in question. The procedure was employed only where the relative variation of k was found to be less than 15 percent, and where the sample size was relatively small; most often, however, such observations were dropped from the analysis.

the effect of the excluded variable. Nearly the only approach possible is to try to avoid study sites where multicollinearity is likely to be a problem, or to design the sample area in such a way that the multicollinearity is broken. In this study, both approaches were used. Nevertheless, multicollinearity remained a problem in some instances, and numerical estimates of the separate BART impacts were not always possible.

A further limitation at many station areas, especially those surrounded by large parking lots, is the fact that there are few or even no buildings, and therefore data points, within several hundred feet of the station. Thus, the estimated coefficients might then indicate that there would be rather large impacts very near the station — if only residential or commercial property were actually located that close. In other words, the estimated coefficient is in this sense "bound" to its empirical domain — it does not necessarily apply to distances closer or further away than what was encountered in the sample. To discourage such inference, the empirical domains of the estimated regression equations are indicated in Appendix A and in the summary of results below.

Other limitations often encountered in econometric research — autoregressive residuals, heterascedacity (unequal residual variance), and non-normally distributed residuals — were not encountered to any significant degree in this study.

The model performed quite satisfactorily, except in the case of the 16th and Mission Street study site in San Francisco, where there were apparently so many other factors not explicitly included in our model that the variation in price changes remained largely random and the model was unable to disentangle a possible BART impact.

2. RESEARCH QUESTIONS AND STUDY ISSUES

A. OBJECTIVES

The present study seeks to determine BART's impact on property prices and rents and associated locational effects in the Bay Area. The results have implications for future policy decisions that attempt to influence prices and rents, and population distribution. Specifically, an explanatory model is constructed for isolating property price and rent impacts which are either exclusively or jointly with other factors attributable to BART. The model's parameters are estimated for several different station areas and for different property types: single family residential property, rental housing, office rentals, and commercial property. Consistencies in the findings lead to conclusions which have general applicability. Finally, BART's effect on property taxes and regionwide, aggregate property prices and rents are examined.

The specific hypotheses we tested were:

1. BART caused an increase in property prices and rents near stations.
2. BART caused a decrease in property prices and rents near surface and elevated trackage.
3. BART caused an increase in total regional property prices.
4. BART property and sales taxes reduced property prices in the BART District.
5. BART caused a temporary decrease in property prices and rentals during its construction.

B. THEORY

Often a public project serves to enhance the productivity of a firm, or the utility of an individual, in a specific region.[5] Whenever this occurs, benefits accrue to firms and households in the region. Such projects, therefore, have the effect of increasing the value of certain locations and, as a result, the initial equilibrium in the markets for land will be disturbed. Eventually one might expect a new set of equilibrium land values and locational patterns to develop. The total bene-

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5. Gains and losses in utility or productivity are, for the purpose of the present discussion, symmetrical. Hence, in the sequel we shall refer only to gains, the case of losses being implied. Likewise, utility and productivity are synonymous expressions for households and firms, respectively; thus, when only one is mentioned, the other one is implied. "Activity," in the economist's jargon, refers to both households and firms and is used when no distinction between households and firms is necessary.

fit from the project equals the sum, over all firms and households (activities), of the changes in productivity and utility, and therefore the changes in land values associated with the transition from the initial equilibrium to the new one.[6]

Classical rent theory asserts that the changes in utility can be measured by changes in land rents, the rationale being that the rental value of a piece of land is bid up until it exhausts the utility or profits of the activity occupying that site. The rental value therefore equals the net utility (productivity) located on that parcel, and benefits can be measured by the changes in these rents. The classical theory thus seems to ignore the possibility of consumer surplus.

Consider an adaptation of the optimal assignment model.[7] Suppose there are m parcels of land and n activities. Activity i, $i=1, \ldots, n$, is willing to pay up to the amount v_{ij} to occupy parcel $j=1, \ldots, m$. v_{ij} can be interpreted as the maximum rent activity i is prepared to pay for all the services provided by parcel j. The value of v_{ij} will depend upon the preferences of activity i as well as on the characteristics of the j^{th} parcel, including its location. Thus, the willingness to pay, v_{ij}, equals the benefits the i^{th} activity envisions to receive from the j^{th} parcel.[8] External economies are assumed non-existent.

Let P_j be the price (rent) of the j^{th} parcel and consider that n activities compete for the m parcels of land. Then an activity will choose to locate on parcel j if, and only if,

(1) $v_{ij} \geq P_j$ and

(2) $v_{ij} - P_j \geq v_{ik} - P_k$; $k = 1, \ldots, m$; where k designates any other parcel but j.

The first inequality states that the activity will not locate on j if the price there exceeds its willingness to pay for that location. The second relation states that the activity will locate so as to maximize consumer surplus. Although the assumption of perfect competition of the optimum allocation model is not required here, it is necessary to assume that there exists an equilibrium which meets the conditions (1) and (2) above, and that the value of alternative users of adjacent properties remains unaffected by the location of i on j.

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6. Robert C. Lind, "Spatial Equilibrium, The Theory of Rents, and the Measurement of Benefits from Public Programs," Quarterly Journal of Economics 87, May 1973.

7. See, e.g., Tjalling C. Koopmans and Martin Beckmann, "Assignment Problems and the Location of Economic Activities," Econometrica XXV, July 1963.

8. More correctly, but not essential for the present argument: the present value of all future willingnesses to pay equals the present value of the stream of future benefits.

Using basic theorems of permutations, it can now be shown that the total net benefit from land associated with a given new land use configuration resulting from a public investment is given by the change in the sum of willingnesses to pay, which equals the change in the total rental value of land plus consumer's surplus. Moreover, only the net change in the value of such land which is directly affected by the project needs to be considered.[9]

The actual land price, P_{ij}, paid by the i^{th} activity for the j^{th} parcel, will be determined by supply and demand. It will be less than or equal to v_{ij}, depending upon the amount of consumer surplus, s_{ij}, the buyer is able to extract from the seller. Thus,

(3) $P_{ij} = v_{ij} - s_{ij}$,

which implies,

(4) $P_{ij} \leq v_{ij}$

since all entities are non-negative.

Because of the possible existence of consumer surplus, it has been argued that land prices do not fully reflect consumer benefits, except for where it can be established that $s_{ij} = 0$.[10] In practice, however, consumer surplus exists only in a competitive market for a homogeneous good or service; all consumers, regardless of their individual willingnesses to pay, are charged the same price as the marginal consumer. On the real estate market the conditions are fundamentally different. Properties are sold, or rentals negotiated, on a piece-by-piece basis with the price negotiated each time directly between the seller and buyer. Thus, consumer surplus is likely to be minimal or even nonexistent in a competitive real estate market.

Even if some consumer surplus remains, the differential

(5) $dP_{ij} = dv_{ij} - ds_{ij}$

shows that if the consumer surplus exists but does not change (i.e., $ds_{ij} = 0$), a change in the price will accurately reflect a change in willingness to pay and therefore in consumer utility. The above results are also valid for this weak assumption of no change in s_{ij}. If the consumer surplus changes over the period of analysis, however, the revealed changes in prices will either over- or underestimate the benefits.

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9. For a mathematical derivation of these results, see Robert C. Lind, op. cit., equations 2.5 and 3.5

10. Ibid.; and Myrick A. Freeman III, "On Estimating Air Pollution Control Benefits from Land Value Studies," Journal of Environmental Economics and Management 1, 1974.

Although it could not be proven that no changes in consumer surplus occurred in the Bay Area during the study period, there is also no reason to believe otherwise. In addition, changes in consumer surplus would have had to occur in a consistent direction at study sites to yield a significant overestimation or underestimation of benefits in the overall conclusions emerging from the analyses.

C. ON THE ESTIMATION OF DEMAND CURVES

There have been several attempts lately to evaluate the impacts of various changes in the environment on property prices.[11] The methods employed are not useful for the purposes required here. The variance in prices or rents has been studied across cities or, within a given city, across census tracts. These studies yield, as Freeman shows, an estimate of only one point on the consumer's marginal value curve, and therefore do not provide sufficient information to identify the entire demand curve,[12] except for where the added restriction that all households have identical demand curves for the environmental improvement can be imposed.[13] Consequently, the models based on cross-sectional property price data can be used only to predict price differentials within a particular region and under the condition of no change over the entire region.

However, it is possible to estimate the demand curve using a two-step procedure utilizing pooled data from a number of study sites. In the first step, property price change functions are estimated across submarkets indexed by distance to BART for each study site separately using consistent data and statistical techniques for all sites. In the second stage, all the site analyses are pooled based on the assumption that all consumers behave alike across all sites. Under this assumption, the site specific estimates can be interpreted as point estimates of the same marginal utility curve and can be combined to identify the marginal utility function itself.[14] This function can then be used to estimate benefits in areas other than those studied.

In the present study the number of study sites is too small, and the number of

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11. See, for example, Ronald G. Ridker, Economic Costs of Air Pollution, Praeger Special Studies in U.S. Economic and Social Development (New York: Frederick A. Praeger, Publishers, 1967), Chapter 6; R. J. Anderson and T. D. Crocker, "Air Pollution and Property Values: A Reply," The Review of Economics and Statistics 54 (1972); and R. H. Strotz, "The Use of Land Rent Changes to Measure the Welfare Benefits of Land Improvement" in The New Economics of Regulated Industries: Rate Making in a Dynamic Economy, edited by Joseph E. Haring (Los Angeles: Economic Research Center, Occidental College), 1968.

12. Myrick A. Freeman III, "Air Pollution Values: A Methodological Comment," The Review of Economics and Statistics 53 (1971), pp. 415-416.

13. Id., "On Estimating Air Pollution Control Benefits from Land Value Studies," op. cit. , p. 77 and footnote 10, p. 78.

14. Ibid., p. 78; and Caj O. Falcke, et al., The Impact of Water Quality Improvements on Residential Property Prices (San Francisco: David M. Dornbusch & Company, Inc., 1975).

variables defining their differences too large, for a formal, statistical pooling of the individual site results. However, a qualitative attempt has been made to search for systematic variations in site characteristics and study results.

A straightforward cross-sectional analysis is, for our purposes, beset with other problems as well. Property prices and rents are determined by a great many variables. If access or proximity to BART is one of them, it certainly is one of the minor ones, the major ones being share size of the property and locational factors other than BART. In a statistical analysis it therefore becomes paramount to try to keep as many as possible of the major determinants constant so that their large variances are unable to "swamp" the impact of the minor variables.[15] The advantage of a "before/after" type analysis now becomes obvious: major price determinants for any given property remain constant from one period to another (sample points with major changes in these variables, like extensive remodeling, additions, etc., would have to be discarded). Account need only be taken of those price determinants which have changed over the period of analysis (e.g., a new school has been built in the neighborhood), or of those variables toward which consumer preferences have changed (e.g., increased sensitivity to automobile traffic and noise). In a cross-sectional analysis, all major attributes which define a property and determine the market price would have to be included in the model. Moreover, the differential (5) above shows that the "before/after" approach remains valid even in the case of consumer surplus, provided, however, that the surplus has remained constant over the period of analysis.

In summary, then, our basic premise is that BART has value to the general public which, in the absence of a market in which the entire output is directly sold, is reflected in the changes in market prices of those properties which are situated near BART. Under plausible assumptions, the analysis of price changes at one site will provide an estimate of a point on the consumer's marginal value function. By combining these point estimates, the entire marginal value curve can in principle be approximated, and future benefits from similar transportation improvements can be inferred.

D. EMPIRICAL CONSIDERATIONS

Consider an attempt to associate directly the variation in property price changes, dP, with corresponding variance in BART-related effects on transportation and environmental quality, dB for short. Such an effort immediately faces an empiric difficulty: how do we operationally (or even conceptually!) define dB? Recall that it is perceived benefits and nuisances which will affect consumer behavior and consequently prices, not necessarily factual changes in accessibility (minutes) or noise (decibels). Nothing short of an index which would reflect the perceived benefits of BART and another one indicating BART-related, perceived nuisances would do in such a direct analysis of dP as a function of dB.

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15. This very same desire to reduce the sample variance of those variables which are not of particular interest is a major feature of Lee's sample design (Douglass B. Lee, Jr., et al., Impacts of BART on Prices of Single Family Residences, BART Impact Studies Final Report Series (Berkeley: University of California, IURD, 1973), pp. 18, 19).

It is plausible to assume that more benefits in some composite way accrue to those located closer to a BART access point and correspondingly more nuisances are felt by those closer to the BART tracks. Therefore, the effects of both benefits and nuisances ought to exhibit a diminishing function in distance from BART, DB.[16] In other words, in a site-by-site analysis where we can assume that the quality of BART service is fairly uniform within each study site, we can approximate the quantity of BART services received by a distance function. However, when making comparisons between the sites, the differences in perceived BART benefits and nuisances will have to be considered. Obviously, for example, noise effects are totally absent at underground stations, and smaller where the tracks are at grade than where they are elevated.

E. ESTIMABLE FORMULATION OF THE MODEL

We have established that the variation in property prices due to BART can be represented as a diminishing function of distance to BART. For the moment, let us disregard any other price determinants in order to facilitate the specification of that distance function.

Although economic theory is insufficiently developed to suggest a functional form for estimating the demand for mass rail transit benefits,[17] it can be deduced primarily from earlier studies of both theoretical and empirical nature[18] that the value of a property, as a function of its distance to an amenity, tends to fall in a nonlinear fashion towards a non-negative limit as distance to amenity increases, in the following general fashion:

$$(6)\quad P = ae^{b/DB}$$

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16. Indeed, most researchers have a priori assumed, and empirically verified, that the capitalization of benefits is inversely proportional to distance from the improvement. See, for example, Douglass B. Lee, Jr., et al., op. cit., Caj O. Falcke, et al., op. cit., K. C. Koutsopolous, "The Impact of Mass Transit on Residential Property Values," Annals of the Association of American Geographers, Vol. 67, No. 4, December 1977; Herbert Mohring, "Land Values and the Measurement of Highway Benefits," Journal of Political Economy, Vol. LXIX (1961), pp. 236-249.

17. "Economic theory gives preciously few clues as to the functional forms appropriate of economic relationships, and the presence of random error terms in stochastically specified equations adds an element of functional ambiguity"—P. J. Dhrymes, et. al., "Criteria for Evaluation of Econometric Models," Ann. Econ. Soc. Measurement, Vol. 1 (1972), pp. 291-324.

18. Among others—Caj O. Falcke, et al., op. cit.; K. C. Koutsopolous, op. cit.; Douglass B. Lee, Jr., et al., op. cit.; David M. Dornbusch and Stephen M. Barrager, Benefit of Water Pollution Control on Property Values, prepared for the U.S. Environmental Protection Agency, Office of Research and Development (Washington, D.C.: U.S. Government Printing Office, 1973); I. F. Pearce, A Contribution to Demand Analysis (Oxford: Clarendon Press, 1964); S. J. Prais and H. S. Houthakker, The Analysis of Family Budgets (Cam-

where,

P = property price
DB = distance to the amenity, in feet
a,b = parameters

Next, let us examine a small change in the price of a given property, from P_t to P_{t+1}, due to changed utility associated with DB. Taking logarithms of (6) and differentiating gives

$$\ln P = \ln a + b(1/DB) \quad \text{and}$$

$$\frac{d(\ln P)}{db} = \frac{1}{DB} \quad \text{or}$$

$$d(\ln P) = db/DB$$

But

$$\frac{dP}{db} = \frac{1}{DB} ae^{b/DB} = \frac{1}{DB}P \quad \text{or}$$

$$\frac{dP}{P} = \frac{db}{DB}$$

Thus,

$$\frac{dP}{P} = d(\ln P) \quad \text{or}$$

$$= \ln P_{t+1} - \ln P_t$$

$$= (\ln a_{t+1} - \ln a_t) + (b_{t+1} - b_t)\frac{1}{DB}$$

or, to simplify the notation,

$$(7) \quad \frac{dP}{P} = \Delta P = \alpha + \beta(1/DB)$$

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bridge, England: University Press, 1955); H. Wold and L. Jureen, Demand Analysis (New York: John Wiley & Sons, 1964); Y. Oron, D. Pines and E. Sheshinski, "The Effect of Nuisances Associated with Urban Traffic on Suburbanization and Land Values," Journal of Urban Economics 1, 1974; R. W. Vickerman, "The Evaluation of Benefits from Recreational Projects," Urban Studies 11, 1974; Henry O. Pollakowski, "The Effects of Property Taxes and Local Public Spending on Property Values: A Comment and Further Results," Journal of Political Economy 81, 1973 -- as well as numerous applications of the basic gravity model.

Still disregarding any other price determinants, our basic model then expresses the change in price not in absolute but in relative terms, and the diminishing distance function is of a simple hyperbolic form.

Consider now the constant term α of (7). The empirical analysis is intended to be in real terms, that is, in constant dollars. Since the data refer to a "before" and an "after" period of time, a price index is required to eliminate any price rise reflecting general price increases. This will isolate the real property price increases due to improved mass transit services. However, if the index is computed properly, it would appear that the constant term α would be redundant if all general price changes were accounted for by the index. That this is not so — for empirical reasons — in the case of the simple specification (7) can be seen from the following situations depicted in Figure 3. To focus the discussion, let us continue not to consider any other price determinants.

First, at the outer edge of the impact area the actual ΔP equals zero; that is, $\Delta P \rightarrow 0$ as $DB \rightarrow DB_{max}$. Now, if α is set to zero, the specification (7) will yield the desired result $\Delta P \simeq 0$ only when DB is so large relative to β that the term $\beta(1/DB)$ becomes negligible. However, preliminary discussions with professionals in the Bay Area real estate market indicate that the impact (if any) generally vanishes rather quickly. $DB_{max} = 4000$ feet, at the most. Therefore, when β is large and DB is restricted in practice to the domain $DB_{min} = 100 < DB < 4000 = DB_{max}$, $\beta(1/DB)$ is never insignificantly small. An offsetting term is needed to bring the value of the function down to zero for large values of DB, especially in such cases where the data indicate the β ought to be relatively large to properly describe the price change for properties abutting BART (see Figure 3(a)). In the simple specification (7) this task is performed by the constant α (see Figure 3(b)).

To see how a relatively large negative constant arises when the simple specification is used in spite of the application of a correct deflator index, consider the following situation. If α in (7) were constrained to $\alpha \simeq 0$, β would have to be small for the model to fit the data at the tail ($DB > 3000$). This, however, would lead to a gross underestimation of the points near BART ($DB < 1000$) (see Figure 3(c)). For example, $\Delta P = 0.5$ for $\alpha = 0$, $\beta = 2000$, and $DB = 4000$, but $\Delta P = 20$ for the same parameter values at $DB = 100$! A constrained least squares criterion would obviously assign a higher value to $\hat{\beta}$ (the estimate of β) and slightly overestimate the values at the tail. By removing the constraint on α, this overestimation can relatively easily be compensated for (by a negative value for $\hat{\alpha}$, the estimate of α, of the order $0 < \hat{\alpha} < -4$).

Second, consider the situation of a smaller area where BART has had an areawide impact, e.g., Glen Park which was, as an area, very poorly served by public transit prior to BART (see Figure 3(d)). Regardless of their exact location with respect to BART, the properties may have gained an areawide appreciation in addition to that which can be related directly to the individual distances to BART access.

Including the constant α in the specification can handle both of the above situations in a simple yet effective way.[19] The need for a constant term is thus prag-

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19. Note also that unnecessary complexity may introduce errors in itself due to algebraic manipulations of data with inherent (measurement) errors. See William Alonso, "Predicting Best with Imperfect Data," Reprint No. 30 (Berkeley: University of California, IURD, 1968).

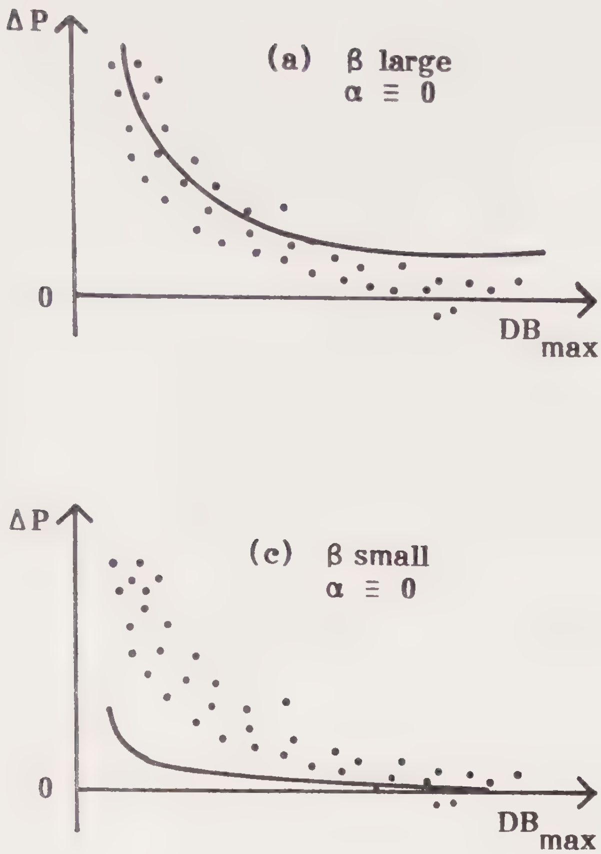

Fig. 3. The Fit of the Function $\Delta P = \alpha + \beta(1/DB)$ in Different Empirical Situations

matic rather than mathematical-theoretical.[20]

In order to estimate properly the effect of the distance to BART (DB) on the variation in property prices, it will be necessary to include in the model as explanatory variables in addition to the DB-function, the effect of major complementarities, substitutes and disutilities which may enhance or diminish the BART effect. Naturally, the list of significant explanatory variables will vary somewhat from site to site -- in one locality a new highway may have had an impact on property values, in another one the influence associated with local schools may be a factor affecting the real estate price mechanism. Neither do the explanatory variables exercise their influence on the dependent variables in exactly the same fashion from site to site. In choosing between theoretically alternative specifications, we shall apply the residual variance criterion which states that since, on the average, the estimate of the residual variance of an incorrect specification exceeds that of the correct specification, one should choose that specification which yields the lowest residual variance.[21] Although applying this criterion does not preclude a wrong specification from being chosen, it does improve specification selection. We shall modify the criterion slightly so that the specification will include only such variables which either contribute significantly in a statistical sense to the reduction in the estimated residual variance or are multicollinear with variables otherwise included in the model.[22] Furthermore, if an a priori realistic specification gives rise to a slightly higher residual variance estimate than another theoretically or practically less appeal-

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20. The full mathematical consequences of an econometric formulation, which always is intended to approximate reality over a restricted range and domain, must not be inferred. For example, the common (arc) income elasticity formula would lead to mathematically undefined results if income were permitted to increase infinitely, strictly speaking, leading to a justification to reject the formula (model) as unreasonable. All theoretical functions have empirical shortcomings. The hyperbolic one proposed above is not defined for a zero argument, and becomes very large for small values of the argument, i.e., Distance to BART. Both semi-log transformations and exponential formulations have similar problems with empirically acceptable domain: in $\ln y = a - bx$, x can never exceed a value such that $bx > a$, and in $y = a - b \ln x$, x must always be larger than zero and y could easily be negative when x is large, which, in case y stands for absolute price or even a price change in many cases, would be unacceptable. In practice, then, whatever functional form one chooses, its domain has to be restricted for empirical reasons.

21. For a discussion of this criterion, see Henri Theil, Principles of Econometrics, Section 11.1.

22. To avoid the risk of having spurious correlations affect the specification, especially when the sample is small and when it contains significant amounts of multicollinearity, the parameters will not be estimated using a stepwise regression procedure. Instead, the entire theoretically accepted specification will be estimated at first. The results, in particular the residuals, are then analyzed. Variables which are thus found to be insignificant and uncorrelated will then be dropped and the model parameters re-estimated in its final form.

ing specification, we shall choose the former specification.

Some of our variables are expressed as stock or level variables and not in a deviation form, despite the fact that we are relating them to changes in property prices. This may seem odd at a first glance. However, stock or level variables, although not themselves in deviation form, may represent deviations if the utility or disutility associated with them has changed during the period of study. To illustrate: the importance of being within walking distance from an elementary school may change with the availability or desirability of school busing; the merit of a corner location may change with changing traffic volumes or patterns. These stock variables should be seen as proxy variables for changing preferences which are much more difficult to observe and measure directly. The resulting regression coefficient will reflect the changed preferences; let prices, P, be a function of X:

$$P_t = \gamma_t X \quad \text{and} \quad P_{t+1} = \gamma_{t+1} X, \quad \text{such that} \quad X_t = X_{t+1} = X.$$

Then a regression of $\Delta P = P_{t+1} - P_t$ on X would yield

$$\Delta P = gX$$

where

$g = g_{t+1} - g_t$, the symbol g denoting estimate of the corresponding parameter γ.

The variables expressing new nuisances or amenities in the study area, of course, represent genuine changes in the physical environment, not just changed preferences. The interpretation of these variables and their coefficients is correspondingly straightforward.

Our previous experience and discussions with key informants indicate that the following list of explanatory variables in general contains all the variables needed to adequately describe the variation in residential property price and rent changes due to public improvement projects:[23]

DE	=	distance to nearest elementary school
DS	=	distance to nearest shopping
B	=	location on a busy street

23. The shape of the lot, or more precisely its deviation from that of a square, has been thought to exercise influence on property prices. However, earlier analyses indicated no support for this hypothesis, so the variable was not employed here. The information is related here only for the benefit of those who may be searching for property value determinants in a more general context.

C	=	location on a corner lot
S1	=	property value in the "before" period
A	=	lot size
DFR	=	distance to a new highway
DFA	=	distance to a new nearest highway access point
DN	=	distance to a new environmental nuisance, such as a new flood area
DA	=	distance to other new facilities, such as a bridge, park, country club, etc.

When studying changes in office rents, the variables DE, DS, B, C, and A can be excluded from the model while the following variables must be added:

STO	=	number of stories in the building
OPAR	=	number of parking spaces in the building
APAR	=	number of parking spaces in adjacent buildings and lots
AGE	=	age of the building
CL	=	building "class," a quality designation commonly assigned by city building departments

In addition, dummy variables will be assigned to indicate whether the building is primarily occupied by small, medium, or large office tenants, and whether the building has a particularly "special" location, for example, Montgomery and California Streets or Market Street in San Francisco.

The implicit assumption behind the distance terms is that the magnitude of the impact of an influencing environmental factor is proportional to the distance between the property and the factor.

The list of variables could be extended to include such variables as change in relative demand for certain types of physical improvements (architectural design, for example) and socio-economic changes like increased crime rate in a particular neighborhood. However, there seems to be no explicit reason why the first type of variables should be non-orthogonal to the variables already included.[24] The change in socio-economic variables, on the other hand, presents

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24. If we omit one or more variables, estimating the model $y = \bar{X}\beta + u$ instead of $y = X\beta + u$, the estimator of the vector will be $\bar{b} = (\bar{X}'\bar{X})^{-1}\bar{X}'y$ instead of $b = (X'X)^{-1}X'y$. Since $E(\bar{b}) = (\bar{X}'\bar{X})^{-1}\bar{X}'E(y) = (\bar{X}'\bar{X})^{-1}\bar{X}'X\beta = M\beta \neq \beta$, $\bar{b}$ is biased, unless the column(s) of X corresponding to the omitted variable(s) is (are) orthogonal to all other columns of that matrix X, that is, the omitted variables are independent of those included. In other words, if we omit such orthogonal variables from the model, we will not bias the coefficient estimates although it will, of course, decrease the total amount of variance explained by the model.

considerable measurement problems, and even if measured would show up only in the constant term when the effects are felt uniformly over the entire community. Thus, although the above is certainly not a totally exhaustive list of all possibly influential variables, it is believed to contain all those variables which might influence the variance of the dependent variable and be simultaneously multicorrelated with the explanatory variable of prime concern here — namely, DB, distance to BART. In the following, we shall discuss these explanatory variables in detail.

In some communities, the perceived benefits or nuisances associated with a particular location vis-a-vis a school appear to have changed over time. Thus, being right next to or on the main route to an elementary school[25] is often not appreciated. The effect rapidly changes to an amenity which peaks out at some distance from the school. Thereafter, the positive effect gradually diminishes to a low at some distance from the school, after which, in most urban communities, one begins to be close to another school. We shall account for this effect by entering the DE-variable as a modified χ^2-distribution. (See Figure 4 on the following page.) Denote this function by DEFCT:

$$(8)\quad DEFCT = K_1(DX)^a \exp\left(-b(DX) + c(DX)^d\right) - K_0$$

$$DX = DE/100$$

The parameters of the DE-function can be estimated by an iterative procedure using the property that the first derivative of the function is equal to zero at (local) minima and maxima:

$$\frac{dDEFCT}{dDE} = a + DX'\left(-b + dc(DX')^{d-1}\right) = 0$$

where

$$DX' = \begin{cases} DX_{max} & \text{or} \\ DX_{min} & \end{cases}$$

As a starting point, determine from a plot of the data at what DE-value the function DEFCT seems to have its local minimum and maximum values, i.e., the values DX_{max} and DX_{min}. Together with arbitrary starting values for the parameters a and d, four simultaneous equations can now be set up and solved for the unknown parameters. The squared deviations of the observations from the estimated curve (that is, the residual variance) give a measure of the fit. By varying the arbitrary value for the parameters a and d, one soon finds a set of parameters which yield a sufficiently small residual variance.

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25. It is beyond the scope of the present report to speculate over the reasons for this effect; suffice it here to recognize its existence.

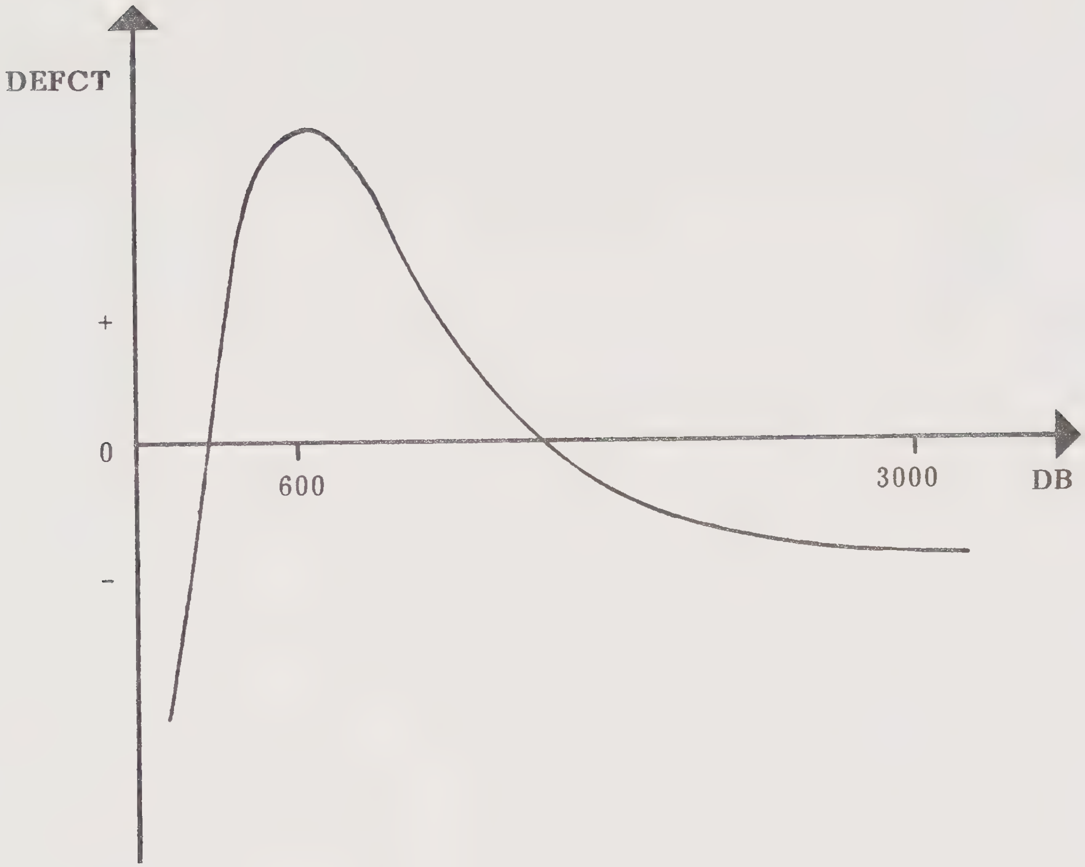

Fig. 4. The DE-function (for maximum and minimum at $DE_{max} = 600$ and $DE_{min} = 3000$, respectively).

We found that, at our study sites, the relevant maximum and minimum values of the DE-function usually occurred at $600 \leq DE_{max} \leq 1100$ and $3000 \leq DE_{min} \leq 4700$ (all values are in feet). Values of 3.0 for the parameter a and 2.0 or 1.01 for d, respectively, yielded the minimum residual variance. The site-specific values for K_0 and K_1 are estimated as part of the multiple regression analysis at each study site.

Being near a new major highway with limited access represents an improvement in transportation and commuting facilities, especially if one happens to be close to an access point. But at the same time, it also constitutes some nuisance in terms of increased air and noise pollution, while it may also be an eyesore to many people. Both effects should diminish fairly rapidly with increased distance from the freeway and the access point, respectively. The nuisance effect probably diminishes at an increasing rate much in the same way as noise diminishes with distance from the source. The value of being near an access point is likewise likely to level off rather quickly.[26] However, being very close to the amenity (the access point) immediately implies a location at least equally close to the nuisance. Hence, depending upon which effect is stronger, the term will either have a positive or a negative sign. However, since it is not our primary purpose here to try to obtain reliable estimates of these factors separately, which necessarily would involve rather complicated mathematical expressions, we shall express the impact of the freeway effects simply by the reciprocals of the distances to the access point over the distance to the freeway itself and without any a priori expectations with respect to the sign of the estimated regression coefficient.

In some instances, increases in roadway traffic volume over time may exert a negative impact on property value changes. To account for this, the location of a given property on a corner or a busy street is indicated by assigning the value 1 to the dummy variables C and B, respectively. Otherwise, these variables take on a zero value.

Property prices in the "before" period, S1, and lot size A are included in the model to reflect the possibility that property prices may have changed differently for different property price and size categories.

As indicated above, the variables entering the determination of office rental rates are to a certain extent different from those influencing housing prices and rents. Four key informants said that, apart from general supply and demand conditions on the market for office space, the main determinant of office rents is current construction costs, while two other informants felt that maintenance costs are the most important determining factor. These factors, however, would presumably affect each rental proportionally the same way and would thus be invariant among the buildings in any given year. However, to account for temporal changes in these factors, the rentals would have to be deflated to some common basis. Unfortunately there exists no suitable office rental index, so

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26. U.S. Department of Transportation, Federal Highway Administration, Office of Program and Policy Planning, Community Effects of Highways Reflected by Property Values, by Hays B. Gamble, et al. (Washington, D.C.: U.S. Government Printing Office, 1973); and David M. Dornbusch and Stephen M. Barrager, op. cit.

the rental data can only be adjusted for office construction costs.[27]

Apart from the above considerations, it is thought that the changes in rental rates are different for taller and newer buildings than for smaller and older buildings. With increasing difficulty to find parking, the number of parking places offered to a tenant either in the building itself or in a nearby garage or lot becomes increasingly important. To account for these factors, the model for office rents includes the variables already listed on page 21. Finally, dummy variables are included to account for such possibilities that the traditionally choice locations has experienced a different change pattern than other locations. Of particular interest in this context is the inclusion of dummy variables for a location on Market and Mission Streets in San Francisco. It was generally believed among key informants that the value of these locations as office locations has changed significantly over the past few years compared to other locations in the station areas. Moreover, since the BART stations also are located under Market and Mission Streets, one could expect some multicollinearity among these locations and distance to the nearest BART station.

The effect of BART, finally, has to be split in two where the tracks are above ground. Whereas proximity to a station -- denoted by DBS — can be expected to have some positive value, closeness to the tracks — denoted by DBT — might, on the other hand, be expected to create nuisances in terms of both noise and visual aspects. The model therefore includes both terms at all sites, with the exception of San Francisco and downtown Oakland where the tracks are entirely underground in the vicinity of the study areas.

All distance-variables in the model are entered in their reciprocal form. Note, therefore, that properties which front on any one of the influences to which the distances are measured have to be defined to have a small but non-zero distance-value, since 1/0 is not mathematically defined. In most cases this is easily accomplished by consistently measuring all distances from the frontage of the property. Only in the case of a property fronting on a street to which distances are measured, an arbitrary value of 50 feet has to be assigned. Otherwise there is always sufficient distance between the influence and frontage of the property.

Previous experience has shown that little can be gained by expressing the various distances in walking distances, time intervals, and so forth, as compared to plain straight-line distance.[28] Since there is no appreciable gain in average accuracy, expedience argues that we express all distances as the shortest line distance from the front line of the properties to the determinants of property prices.

To complete the specification of the model, we make the classical assumptions that the error term of the model is normally distributed with zero mean and constant variance. We also assume that the data matrix at each study site has

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27. See Appendix A for a more detailed description of the indexing of both sales prices and rental data.

28. Louis Berger, Incorporated, Methodology to Evaluate Socio-Economic Benefits of Urban Water Resources, prepared for the U.S. Department of the Interior, Office of Water Resources Research, 1971.

full column rank. The fulfillment of these classical assumptions makes the ordinary least squares estimator an unbiased and consistent estimator of the unknown parameters of the model.

F. STUDY PROCEDURE

As already noted above in Section C, to detect small influences, it is important to keep constant as many as possible of the major determinants in order to prevent their large variances from completely overshadowing the impact of the minor variables.

Our study procedure then involved analyzing the price differentials for properties which sold or rented twice: during defined periods before and after construction of BART, before and during construction of BART, and during and after construction of BART.[29] All prices and rents were expressed in constant 1975 dollars through the use of appropriate price and rent indices before including them in the regression analyses (see Appendix A for details).[30]

Price and assessment data were collected mainly from the assessors' offices, except for Alameda County where the Assessor, Mr. Hutchinson, did not agree to cooperate in our data collection efforts. The information on residential and office rents came from private real estate companies, leasing agencies and building managers. The data collection effort is described in detail in Appendix C.

The analysis of price changes of commercial property, especially large office buildings, was complicated by two problems. First, there were not very many sales of commercial properties which meet our time period and other requirements. Secondly, the sale price of a commercial property often reflects many determinants other than those directly related to the property itself. It was, therefore, possible to conduct only a rent/lease analysis for this segment of the market, except for the Mission District in San Francisco where there has been a sufficient turnover of small, but mixed, commercial property. Rents and leases, however, ought to reflect real estate values at least as well as prices, and in the case of commercial property, probably even better than prices due to the above-mentioned reflection of other factors in the commercial building prices.

The observed price and rent differentials were regressed in a multiple regression analysis against distance to both BART station and BART track (if above ground) and to other locational factors thought to have exercised an important influence on the price information. Our primary interest was to determine wheth-

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29. In a few instances where the recorded sale price obviously did not reflect a true market price or included substantial improvements in the property, the sale price S_j was substituted for by kA_j, where A_j is the assessed value for property j and k is the average ratio of sales prices to assessed values for the area in question. The procedure was employed only where the relative variation of k was found to be less than 15 percent, and where the sample size was relatively small; most often, however, such observations were dropped from the analysis.

30. The year 1975 is the chosen base year for all LUUD projects.

er or not the estimated coefficients of the BART-related variables were statistically stable enough that we could draw some inferences with respect to the research hypotheses stated in Section A, above.

G. LIMITATIONS OF THE ANALYSIS

The limitations of the analysis here are more empirical than conceptual. In several instances multicollinearity among the explanatory variables precluded us from having very high confidence in the numerical values of the coefficient estimates — fortunately, though, the standard errors of the coefficients were often sufficiently small for us to reject the null hypotheses of no BART impact. Moreover, these case studies with significant multicollinearity were also those in which we had difficulties in obtaining enough sample points. We could not therefore afford a different sample frame designed to break the suspected multicollinearity. For example, where a freeway access point is in the immediate vicinity of a BART station it would be advantageous to design the sample so that the covariation between the station and the access point is minimized.

A further limitation at many station areas, especially those surrounded by large parking lots, is the fact that there are very few or even no physically possible data points within several hundred feet of the station. Thus, the estimated coefficient might then indicate that there would be rather large impacts very near the station — if only residential or commercial property were actually located that close. In other words, the estimated coefficient is in this sense "bound" to its empirical domain — it does not necessarily apply to distances closer or further away than what was encountered in the sample. To discourage such inference, the empirical domains of the estimated regression equations are indicated in Appendix A and in the summary of results below.

Other limitations often encountered in econometric research — autoregressive residuals, heteroscedacity (unequal residual variance), and non-normally distributed residuals — were checked for both analytically and graphically, but were not encountered to any significant degree in this study.

The model performed quite satisfactorily, except in the case of the 16th and Mission Street study site in San Francisco, where there were apparently so many other factors not explicitly included in our model that the variation in price changes remained largely random and the model was unable to disentangle a possible BART impact.

3. FINDINGS--BART'S EFFECTS ON PROPERTY PRICES AND RENTS

Figure 1 on page 6 shows the study area locations and the type of transactions studied at each site. In the following discussion, the impacts of BART are summarized, and where applicable complemented by results of the other LUUD projects and other BART Impact Program studies. The main difference between the summaries and the technically detailed analyses in Appendix A is that the conclusions below are presented in a somewhat more affirmative manner—statistical testing formally allows only rejection, not acceptance, of research hypotheses. Apart from the fact that the conclusions in the summary are supported by all available evidence, the primary motive for the summary's different emphasis is a desire to present the results in a more useful or comprehendible way to the non-technical reader. The reader familiar with econometric terminology should profit from first reading the introduction to Appendix A before proceeding with this chapter (or the remainder of Appendix A).

Since it would have been impractical for us to compute our own indices, we had to rely on readily available, published price and rent indices to express the market transactions in constant, 1975 dollars. Despite the fact that these indices have desirable mathematical properties (see Appendix A for a detailed discussion), problems may remain. If the index is computed for a very large area, it may not adequately reflect local conditions. On the other hand, if the index applies only to a very small area around a study site, deflating the market transactions by the index may effectively "wash away" or alter the areawide impact of BART. In the present context, an incorrect index would affect the constant term of our model. Therefore, caution is urged in interpreting the numerical magnitudes of the constants in the estimated regression equations, and the relationships of the graphed curves to the horizontal, zero-change line in the figures of this chapter.

A. RESIDENTIAL PROPERTY PRICES

El Cerrito Plaza

Neither the BART station nor the elevated tracks in the area had any appreciable effect on residential property prices. The Environmental Impact Project of the BART Impact Program likewise found very little impact in this area.[31] BART patronage is relatively small at the El Cerrito Plaza station, suggesting a low interest in BART services among the area's residents. The elevated tracks parallel existing railroad tracks. BART-associated noise, physical barrier, and visual impacts therefore constitute only additional marginal effects. Moreover, the station is located adjacent to an existing shopping center, so local adjustments to increased traffic and parking in the area had already taken place.

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31. DeLeuw, Cather & Company, Responses of Nearby Residents to BART's Environmental Impacts (Berkeley: BART Impact Program Environmental Impact Project Technical Memorandum, 1977), pp. 29, 30.

The sales transactions studied were between 525 and 3,075 feet from the station and between 150 and 3,075 feet from the tracks.

Glen Park

Proximity to the BART station had a small yet statistically significant effect on property prices during the time period when the expectations vis-a-vis BART service were still high, i.e., just before service began. The estimated model, when evaluated at the means of all independent variables except for distance to BART, is[32]

$$\overline{S2/S1} = 1.011 + 25.882(1/DBS) \quad \text{for}$$

$$150 \leq DBS \leq 2{,}650$$

Thus, the following percentage increases in prices, $\Delta P\% = 100 \times (\overline{S2/S1} - 1)$, would have been expected at varying distances (in feet) from the Glen Park station (see Figure 5):

DBS	Δ P%
150	18
300	10
500	6
1,000	4
2,000	2
2,650	2

Since BART service began, the positive impact of proximity to the station has disappeared, possibly because of the increased but unrelated automobile traffic in the vicinity of the station. The constant of the model, however, remains significantly larger than unity. Thus, property prices in the period after service

32. That is, $\overline{S2/S1}$ gives the expected value of the relative increase in property prices, S2/S1, for an average property at varying distances from BART. A similar interpretation applies to R2/R1. To evaluate the function at the means of those variables held constant is akin to the same practice in traditional partial equilibrium analysis. It is also appropriate in statistical analyses because the precision of any estimated model diminishes with distance from the gravity of the sample space.

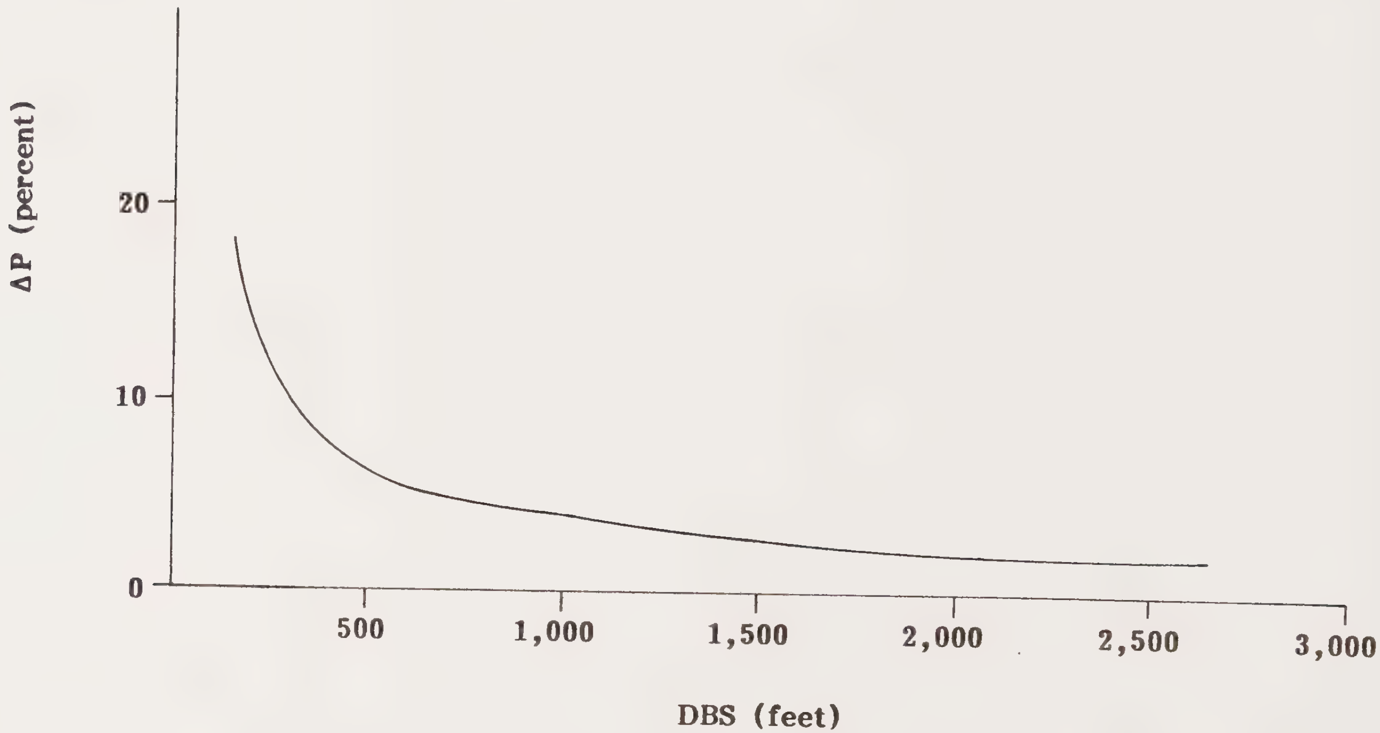

Fig. 5. Percentage Increase in Residential Property Prices -- Glen Park; Pre-Service Effect

began have, on the average, risen areawide in Glen Park 5 percent more than those in the surrounding area. Key informants attribute this to BART's improvement of public transit access for the residents of Glen Park.

Mission and 16th Street

The model and the variables of this study, including proximity to a BART station, do not explain any of the observed variation in property price changes in this area. A probable reason for this is the influx of less desirable activities into the area which were displaced from redevelopment projects elsewhere in the city. Not only has this caused an areawide decline in real property prices, but the effect has been very scattered or random in terms of our model. As a consequence, the model may not have been able to "sort out" a BART effect—if one indeed exists—from the overall, large variance in property price changes. Key informant interviews were equally inconclusive. Thus, the effect of BART here remains undetermined.

Mission and 24th Street

In the early period, when anticipations vis-a-vis BART service were relatively high, a location close to the BART station was valued more than a location further away. The estimated model, when evaluated at the sample means, is

$$\overline{S2/S1} = .987 + 108.978(1/DBS) - 97.410(1/DS)$$

$$DS = 500.070 + .570(DBS) \quad \text{for}$$

$$250 \leq DBS \leq 2{,}800$$

where the second equation attempts to account for the observed multicollinearity between distance to BART and distance to shopping in the sample. Thus, the following percentage changes in prices, $\Delta P\%$, would have been expected at varying distances (in feet) from the BART station (see Figure 6):

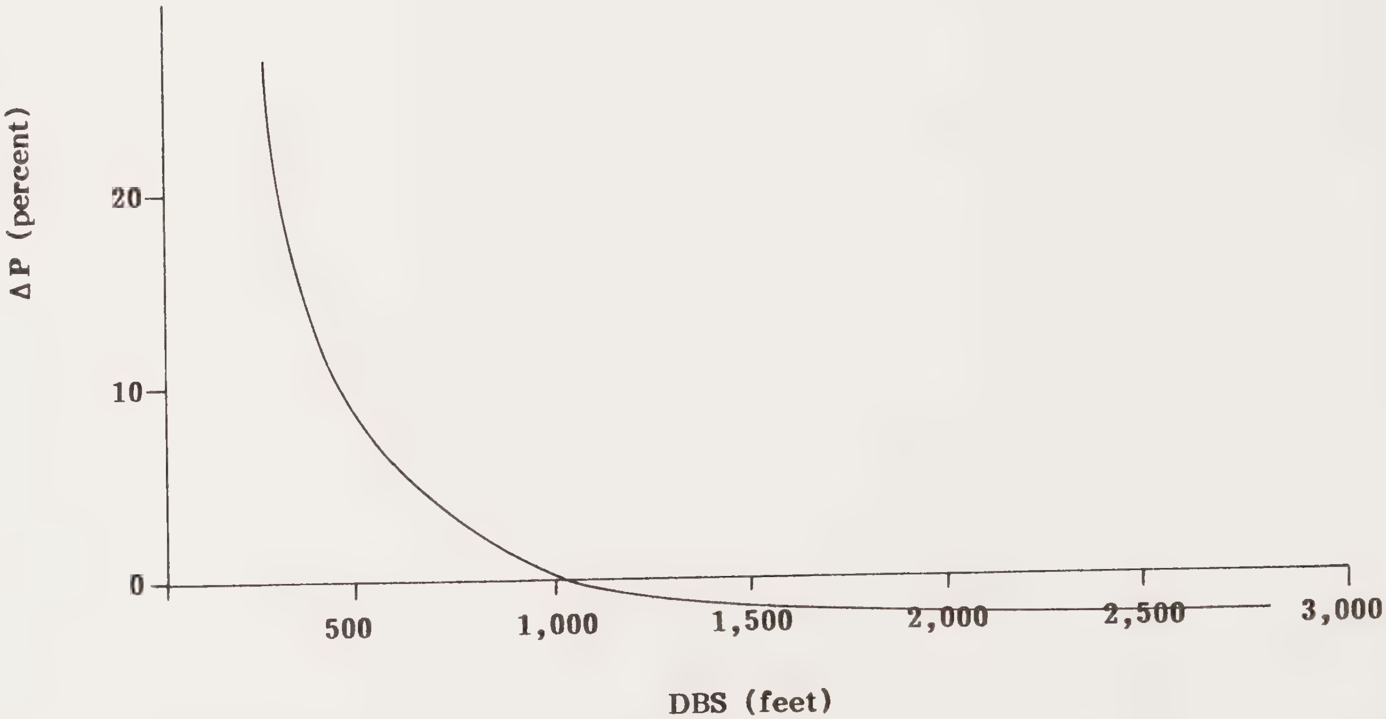

Fig. 6. Percentage Increase in Residential Property Prices -- Mission and 24th Street; Pre-Service Effect

Residential Property Prices -- Mission - 24th St./South Hayward

DBS	Δ P%
250	27
500	8
1,000	0
2,000	-2
2,800	-2

We note, however, that because of the multicollinearity the above calculated changes must be attributed jointly to DBS and DS.

After BART service was initiated and anticipations diminished, the additional value of a location close to the station also started to vanish. From a longer term perspective, then, there is no BART effect.

South Hayward

Because of lack of data from the early Sixties at this site, the only time period that could be studied was the Construction/After period. At South Hayward an exceptionally large study site was defined to test whether BART's impact would extend beyond the otherwise presumed 2,000-to-4,000-feet impact area.

It was found that proximity to the station had a positive effect on property prices. The impact of closeness to the tracks, which here are at grade but parallel to an existing railroad track, was negligible. The two variables, however, are somewhat multicollinear so that only their joint quantitative effect can be evaluated. The estimated model, when evaluated at the sample means, is

$$\overline{S2/S1} = .945 + 139.437(1/DBS) - 10.824(1/DBT)$$

$$DBT = 628 + .583(DBS) \quad \text{or}$$

$$DBS = 5,164 + .411(DBT) \quad \text{for}$$

$$1,000 \leq DBS \leq 12,000 \quad \text{and}$$

$$200 \leq DBT \leq 10,300$$

Thus, the following percentage changes in property prices, Δ P%, would have been expected at varying distances (in feet) from the station (see Figure 7):

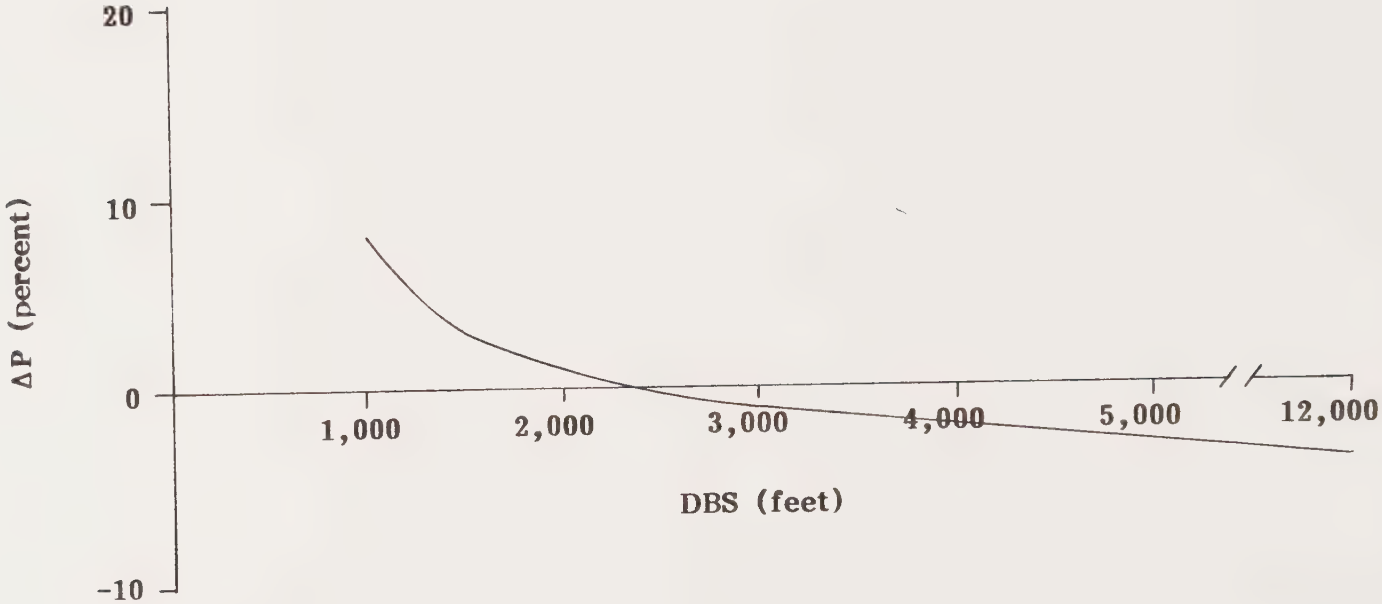

Fig. 7. Percentage Increase in Residential Property Prices -- South Hayward; Immediate Effect

Residential Property Prices -- South Hayward / Walnut Creek

DBS	Δ P%
1,000	8
1,500	3
2,000	1
3,000	-1
4,000	-2
5,000	-3
12,000	-4

Compared to the surrounding areas, real property prices declined on the average by 3 percent over the study period. Thus, by comparing the average to the above figures, the effect of BART cannot be said to have extended beyond 4,500 feet from the station. The key informants' conclusions concur with the analytical results above. The Environmental Impact Project likewise found that negative responses to BART were minimal and that BART's presence was highly regarded by the residents of the area although relatively few of them actually used the service.[33] Evidently, the mere existence of an option to take BART has a positive value, possibly even larger than that of its actual, current use.

Walnut Creek

As in El Cerrito, the rather poor availability of sales data from the period before BART has led to fairly small sample sizes and, moreover, has precluded us from defining our sample frame to break the multicollinearity now present in the data.

Proximity to the Walnut Creek BART station appears to have had a positive effect on property prices in the early period when anticipations of BART service were high. At the same time, the fear of adverse effects such as noise and visual intrusion caused properties near the BART tracks to decrease slightly in price, but this decrease was overshadowed by the positive effects of station proximity.

The positive effect of proximity to the BART station has since then turned negative. The reversal is probably due to an overflowing BART parking lot and traffic problems around the station. An alternative specification of the model to account for the nuisances associated with very close proximity to the station failed to yield statistically stable results, perhaps due to the small sample sizes. Since construction, the negative effect associated with proximity to the BART tracks has remained but has probably decreased in absolute magnitude.

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33. DeLeuw, Cather & Company, op. cit., pp. 33 - 35.

Residential Property Prices -- Walnut Creek

The longer term view shows a net negative effect of immediate proximity to the Walnut Creek BART station. Closeness to the tracks continues to affect property prices negatively but only marginally so; even as close as 100 feet from the tracks, the price for a typical $75,000 to $80,000 house would only be $8,000 less than if it were located 2,000 feet away from the tracks (these figures are only approximate due to the existing multicollinearity, but they do illustrate the magnitudes involved).

Because of the econometric problems encountered at this study site (see Appendix A for details), we must refrain from making any further numerical estimates of BART's effects on residential properties in Walnut Creek. However, the coefficient estimates are stable and the conclusions expressed above are supported by the key informants.

B. RESIDENTIAL RENTS

Rents were not expected to reflect benefits that were anticipated to occur several years in the future. Rental analyses were therefore performed only for a period extending from immediately before BART service began to the present.

Mission District

No impact of BART on rentals was detected in the Mission District, encompassing both the 16th and the 24th Street stations. In general, rents had increased in the Mission more than in the Bay Area as a whole, but this could not be attributed to BART.

Walnut Creek

Proximity to the BART station showed a positive effect on rents, while closeness to the tracks evidenced a negative, though smaller, effect. Although these effects were in the expected direction, they were not strong enough to enable us to reject the hypothesis that BART had no effect on residential rents.

Rental data were collected for buildings up to 14,000 feet from the Walnut Creek BART station partially to obtain a larger sample but also to check whether BART's potential effect would extend that far away. Although the BART terms themselves turned out to be statistically insignificant, the constant in the model is positive and highly significant. This indicates that rents in the entire study area

have risen more than in the Bay Area in general and it is conceivable that this is at least partially due to BART. When BART opened service to Oakland, and especially to San Francisco, the improvement in accessibility for the whole area was substantial. One of the key informants thought that BART had had such an areawide effect, although marginal compared to other influences.

No deliberate effort was made to obtain data for an analysis of rents since BART opened for service. However, as a by-product of our primary data collection we obtained nine pairs of rentals at varying dates since 1973.

Again, the analysis fails to show any stability in the directly BART-related coefficients. It is, however, worth noting that while the coefficient of 1/DBS (proximity to the station) has become notably large and its standard error has relatively decreased, closeness to the tracks has become even less important. Perhaps the initial fears of noise and other adverse effects from proximity to the tracks have proven unfounded as far as the market as a whole is concerned. Individual renters may still find closeness to the tracks undesirable but apparently there are enough renters on the market who are insensitive to such adverse effects.

The constant in the estimated equation, while remaining statistically significant, has dropped below unity, and the average value of the whole function is also less than one (.996). This may indicate that the initial boost in areawide accessibility, and rents, has since gone and the rents in the area have followed the general pattern in the Bay Area.

It is further notable that the analysis of rental changes does not corroborate the findings of the analyses of the property price changes in the area. In particular, in Walnut Creek the renters appear to be less sensitive to the negative influence of the BART station with its overflowing parking lot and attendent automobile traffic. Suggested reasons for this might be that renters have available parking on the premises which is protected from outside users (whereas street parking in front of single family residences is not similarly protected) and apartment renters may consist to a larger extent of adults who may be less sensitive to surrounding traffic than families with small children.

C. OFFICE RENTS

Downtown San Francisco

The study site here encompasses two of the three downtown stations, namely Montgomery Street and Embarcadero. Proximity to these two stations has had a positive but very marginal effect on office rents in the area. However, a location near a station entrance nearly always combines with a location on Market Street so the joint effect must be considered.[34] The estimated model then, when evaluated at the means, is

$$\overline{R2/R1} = .825 + 1.387(1/DBS) - .0737(MA)$$

$$MA = \begin{cases} 1 & \text{if located on Market Street} \\ 0 & \text{otherwise} \end{cases} \qquad \text{for}$$

$$20 \leq DBS \leq 1{,}850$$

Thus, the following percentage changes in office rents, $\Delta R\%$, would have been expected at varying distances (in feet) from BART (see Figure 8) —

assuming a Market Street location:

DBS	ΔR%
20	-18
50	-22
100	-24
200	-24

assuming a non-Market Street location:

DBS	ΔR%
50	-15
100	-16
200	-17
500	-17
1,000	-17
1,850	-17

---

34. On the average, office rents in San Francisco and Oakland have increased less than building costs, which were used to deflate the rental figures (for office rents no suitable rent index exists; see Appendix A). Hence, BART's positive effect amounts to reducing the decrease compared to other buildings.

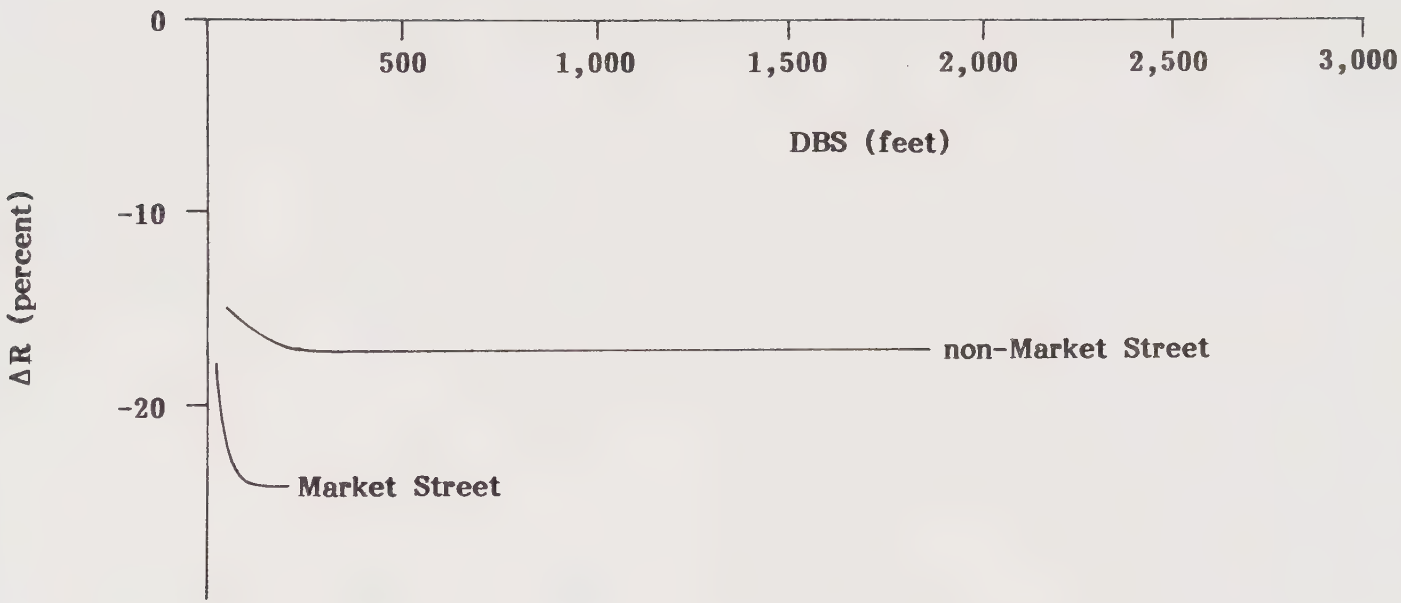

Fig. 8. Percentage Changes in Office Rents -- Downtown San Francisco; Immediate Effect

Office Rents -- Downtown San Francisco / Downtown Oakland

The average decline in office rents, compared to building costs, was 17 percent. Thus, BART's effect is very marginal and disappears after only 100 feet from a station. Since the domain of the effect apparently is so small it was not surprising that the key informants were very divided in their assessment of BART's impact on office rents.

Downtown Oakland

The study area encompasses all three downtown Oakland stations. Most of the buildings in our sample, however, are closer to the 12th and 19th Street stations than to Lake Merritt.

Proximity to a BART station has increased rents in downtown Oakland since BART service began. However, this effect is discernible only for the upper portion of the rental range, even within a single building, possibly implying that BART has only affected the more prestigious new office spaces in the newer office buildings in Oakland. The estimated model, when evaluated at the sample means, is for the upper range of office rents:

$$\overline{U2/U1} = .837 + 22.503(1/DBS) \quad \text{for}$$

$$75 \leq DBS \leq 4{,}000$$

Thus, the following percentage changes in office rents, $\Delta R\%$, would have been expected at varying distances (in feet) from a BART station (see Figure 9):

DBS	ΔR%
75	14
100	6
200	-5
300	-9
400	-11
500	-12
1,000	-14
2,000	-15
4,000	-16

On the average, all office rents decreased by 14 percent compared to office building costs. Thus, a location closer than 1,000 feet from a BART station not only helped to offset this general decline, but a very close proximity actually

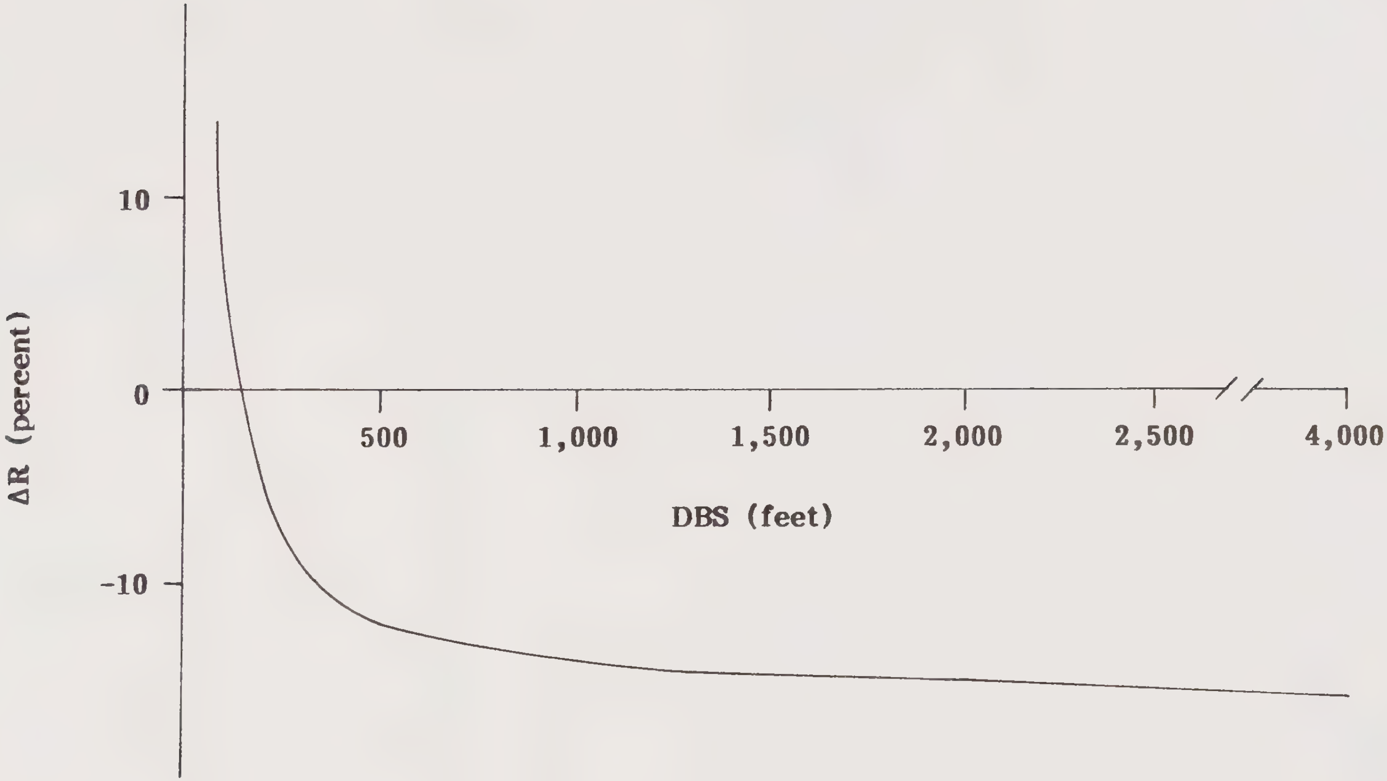

Fig. 9. Percentage Changes in Upper Range Office Rents -- Downtown Oakland; Immediate Effect

caused a fairly substantial increase in office rents in Oakland. As noted above, the effect was limited to space renting at the upper end of a building's rental spectrum.

It must be remembered, however, that in the sample most of the buildings which are near a BART station are also near the new City Center Project. Part of the estimated regression coefficient above may therefore reflect the City Center's effect and not solely and directly proximity to BART. But then again, it may be argued that the City Center itself is a BART effect.[35] A direct comparison of the Oakland results with those for downtown San Francisco is further invalidated by the fact that the above relation applies only to the upper range rentals whereas the San Francisco sample represented median rents. We do note, however, that the coefficient estimate of 1/DBS for the Oakland medium range sample (2.382), although statistically unstable, was remarkably close to that of the San Francisco sample (1.387).

Walnut Creek

No discernable impact was discovered on office rents in Walnut Creek from the time when BART construction was almost completed to when service to Oakland began. However, since trans-Bay service began in 1974, proximity to the Walnut Creek BART station has had an effect of increasing office rents.

Proximity to the station and number of stories in the building are somewhat multicollinear in the sample. If we represent this multicollinearity by the simple linear correlation between the two variables (see Appendix A), the estimated model, evaluated at the sample means, is

$$\overline{R2/R1} = .925 + 99.225(1/DBS) \quad \text{for}$$

$$450 \leq DBS \leq 11{,}100$$

Thus, the following percentage changes in office rents, $\Delta R\%$, would have been expected, at varying distances (in feet) to the BART station and implied number of stories (see Figure 10):

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35. John Blayney Associates/David M. Dornbusch & Company, Inc., Study of the Office Construction Industry (Berkeley: BART Impact Program Land Use and Urban Development Project Working Paper, 1977.

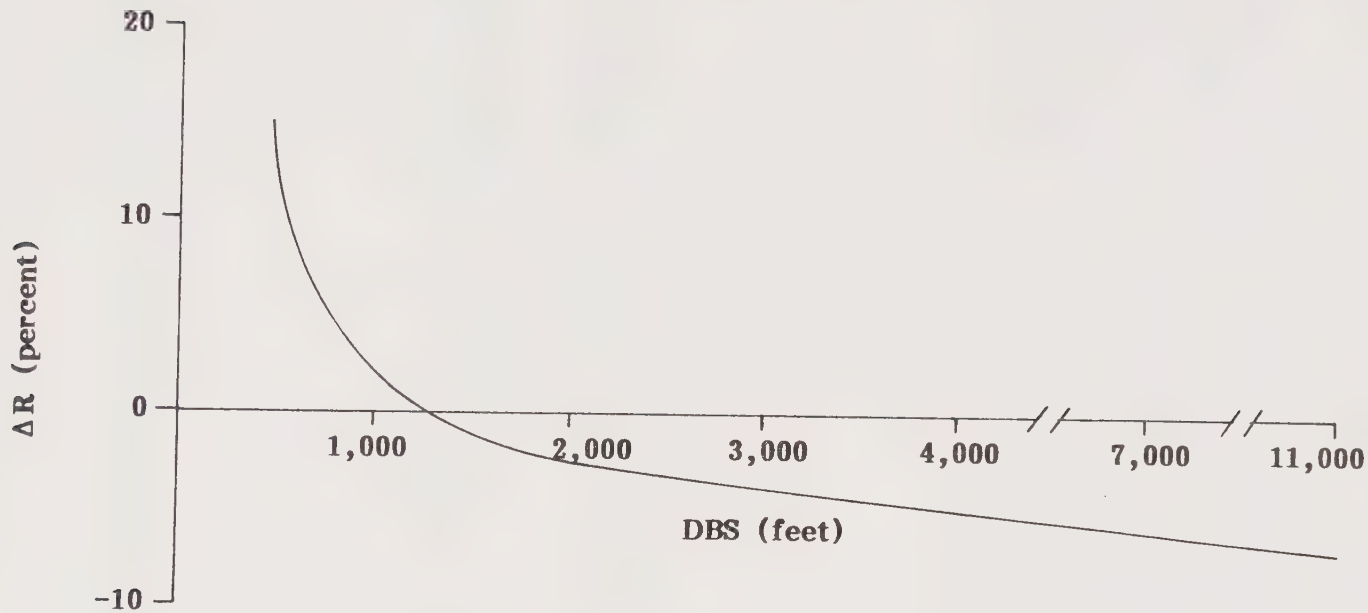

Fig. 10. Percentage Changes in Office Rents -- Walnut Creek; Immediate Effect

Office Rents -- Walnut Creek

DBS	Implied Number of Stories	ΔR%
450	3.9	15
600	3.9	9
1,000	3.8	2
2,000	3.6	-2.5
3,000	3.4	-4
4,000	3.2	-5
7,000	2.7	-6
11,100	2.0	-7

On the average, office rentals in Walnut Creek had increased by nearly 2 percent during the period, compared to office construction cost increases. This is in sharp contrast to the general decline of the deflated office rentals in San Francisco and Oakland. Whether or not this can be attributed to BART or to economic growth in Central Costa County, or to both, could not be determined from the present analysis.[36] The above figures nevertheless indicate that the joint effect of proximity to the BART station and building height have had an increasing effect on office rentals, once service to San Francisco had begun.

The ten key informants were equally divided between those who said that BART had absolutely no impact on office rents and those who thought that proximity to the station has had a positive impact.

D. COMMERCIAL PROPERTY PRICES

Among the sites chosen for this study, only the Mission District in San Francisco yielded enough data for statistical analyses of changes in commercial property prices.

Mission District

The sample here consists of information on the repeat sale of various types of commercial property. Mainly small properties comprise the sample: typical exam-

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36. Douglass B. Lee, Jr., et al., Impacts of BART on Prices of Single Family Residences, BART Impact Studies Final Report Series (Berkeley: University of California, IURD, 1973), infer that growth in central Contra Costa from 1961 to 1971 "was the consequence of increased aggregate demand rather than improvement in transportation."

ples are gas stations and retail stores. Because such property has a relatively low turnover rate, the sample size is necessarily very limited. The samples, moreover, are intertwined by multicollinearity, making formal hypothesis testing hazardous.

Nevertheless, the available evidence, including key informant opinions and the results from the residential analyses, indicate that BART had some positive impact on commercial property in the Mission at the time when anticipations about BART were still high, but this impact has since disappeared.[37]

To get a numerical estimate of the joint effect of anticipated BART service and other variables, the existing multicollinearity can be accounted for by deriving values for the explanatory variables which are implied by the simple linear correlations among the variables, given various values for DBS. Thus, the estimated equation yields the following results (see Figure 11):

DBS	S2/S1
100	2.811
200	1.356
500	1.141
1,000	.987

Hence, the prices for commercial property near a BART station in the Mission are estimated to have nearly tripled in anticipation of BART service. This positive impact, however, diminishes rapidly and vanishes totally by some 1,000 feet from the station.

E. SUMMARY OF REGRESSION ANALYSES

The table on the following page summarizes where and when BART impacts were

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37. Key informants reported many bankruptcies among small businesses in the area since the construction of BART began. Although these coincided with the general recession of that time, another plausible explanation might be that anticipations of increased patronage (due to BART) increased commercial rents. Then the construction period brought a decline in business and many firms probably had to borrow capital to carry them over to the period when BART service began. When the anticipated growth in business then failed to materialize, many of the firms went under and the rent levels adjusted to show no further dependency on proximity to BART.

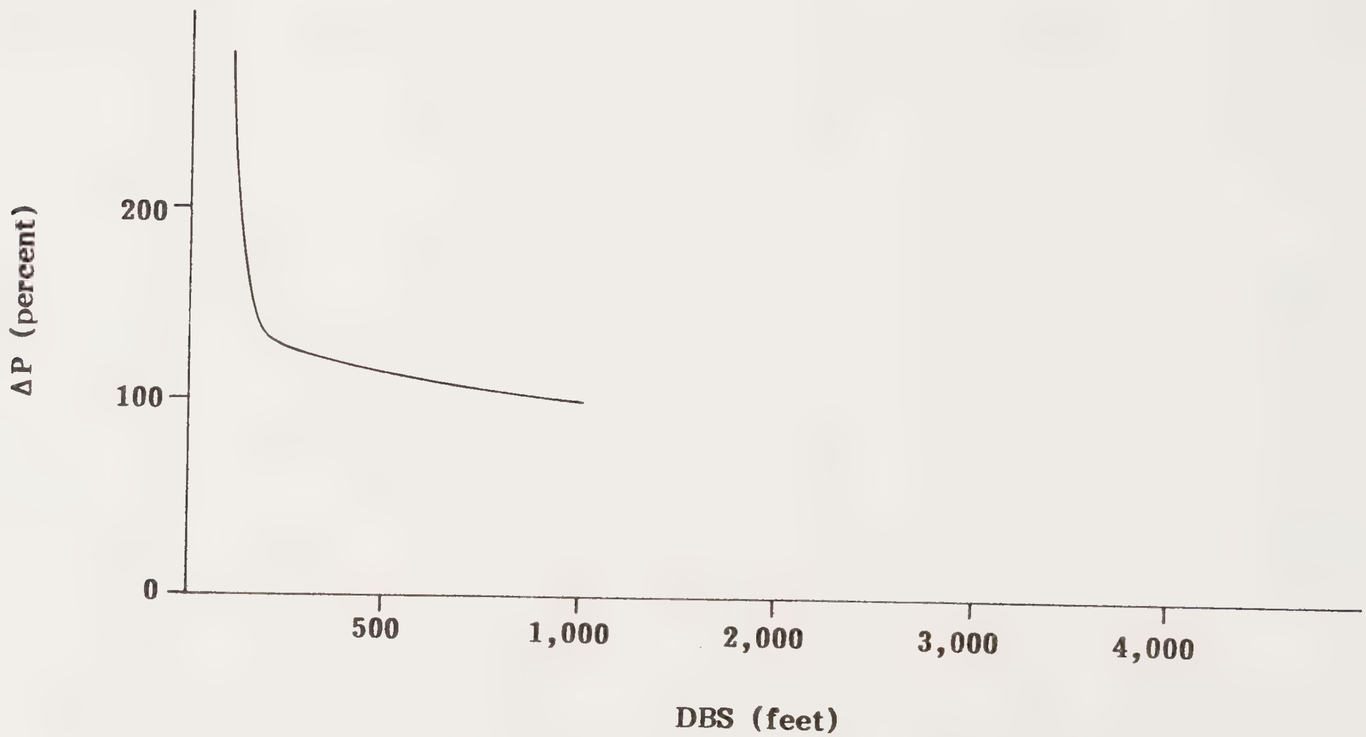

Fig. 11. Percentage Change in Commercial Property Prices -- Mission District; Pre-Service Effect

found. A "+" indicates a positive impact and a "-" correspondingly a negative effect. A "0" indicates no impact. Parentheses denote that the finding is tentative at best.

Station Area	BART Station Impact: Before Service	BART Station Impact: After Service	BART Station Impact: Long Term	BART Track Impact: Before Service	BART Track Impact: After Service	BART Track Impact: Long Term
Residential Property Prices:						
El Cerrito Plaza	0	0	0	0	0	0
Glen Park	+	0	(+)[a]	tracks underground		
Mission/16th Street	indeterminate			tracks underground		
Mission/24th Street	+	0	0	tracks underground		
South Hayward		+			0	
Walnut Creek	+	-	-	-	-	-
Residential Rents:						
Mission		0		tracks underground		
Walnut Creek		0			0	
Office Rents:						
San Francisco		+		tracks underground		
Oakland		+[b]		tracks underground		
Walnut Creek		+		not thought to affect office rents		
Commercial Property Prices:						
Mission	+	0	0	tracks underground		

a. Areawide effect, only.

b. Only after trans-Bay service began.

In sum, BART appears to have had a positive effect on property prices before service began, reflecting anticipated BART benefits. Since then, the impact on property prices has largely disappeared, except in South Hayward. Residential rents have not been affected at all. Office rents, however, show a positive impact at all study sites and there are some indications that this effect is growing stronger (although the statistical evidence is still weak). That office rents show a more consistent impact than either residential prices or rents probably reflects the fact that work locations have traditionally been more sensitive to mass transit access than residential neighborhoods, which, especially in the suburbs, are auto-oriented.

The widely anticipated negative impact of proximity to the BART tracks varies; it is negligible or nonexistent where BART causes only a marginal increase in ambient noise and other nuisances.

In a previous study of BART's impact on property prices, no impact from local proximity to a station was found.[38] The impact of BART tracks was not studied separately. The difference in results from those obtained here and in the Environmental Impact Project[39] is probably due mainly to different time periods and research emphasis. Lee's study also focused on areas where the automobile is the primary means of transportation to and from the station so that variations in distance within a few thousand feet are insignificant.

The primary conclusions of the Environmental Impact Project[40] are supported by the present study:

— the effects of overflow parking at stations and noise along aerial lines are viewed as BART's worst impacts;

— the BART impacts are limited to a very small area (except for where BART has had an areawide effect on accessibility)

— perceived negative impacts are smaller than those anticipated from technical assessment;

— in comparison to other price and rent determinants, BART's influence is small.

F. THE EFFECT OF BART-RELATED TAXES ON PRICES AND RENTS

Economic theory suggests that future costs and benefits are capitalized to form the present value of a piece of property. The rational buyer, therefore, would capitalize any changes in future taxes, such as the additional sales tax in the counties served by BART and possibly increased property taxes.

Although Wallace Oates shows that capitalization of property taxes does take place,[41] his study methods have been seriously challenged on theoretical grounds

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38. Douglass B. Lee, et al., op. cit. Andrejs Skaburskis, "The Rockridge BART Station's Land-Use Impact," unpublished (June, 1976), also studied property prices. However, he was so severely constrained in obtaining and analyzing price data that his results (no significant impact) are of limited use as reference.

39. DeLeuw, Cather & Company, op. cit.

40. Ibid., pp. i, ii.

41. Wallace F. Oates, "The Effects of Property Taxes and Local Public Spending on Property Values: An Empirical Study of Tax Capitalization and the Tiebout Hypothesis," Journal of Political Economy 77 (1969), pp. 957 - 970.

and, when replicated for the San Francisco Bay Area, failed to show evidence of capitalization of taxes in practice.[42] Others have likewise found that their empirical results were insensitive to a sophisticated treatment of capitalization and time.[43] The average home buyer (or renter) does not in this respect seem to conform to the theoretical model of a rational consumer. Although future taxes certainly figure in the calculations of monthly payments, they appear to have little or no differentiating effect on market prices.

Both the Assessor and his Deputy in Alameda County stated that BART has had no effect on property prices in the County and hence not on property taxes either. The Assessors in San Francisco and Contra Costa could not say that BART specifically had increased property taxes, although taxes areawide had gone up in certain areas now served by BART.

The sales tax in the three counties served by BART is one half of one percent higher than in surrounding counties. Real estate agents suggest that this has had no impact on the geographical distribution of aggregate demand in the Bay Area. The effect, even if present, would have been invariant over our study sites and could therefore not have affected the regression results.

Finally, the impacts on property prices by BART detected in this study are small and sharply limited in their geographical extent.

All of the above observations contribute to our conclusions that BART-related taxes have probably not affected property prices to any significant degree.

G. IMPLICATIONS FOR DISTRIBUTION OF ACTIVITIES

Significant increases in property prices and rents could effect the geographical distribution of various socio-economic groups. BART could therefore have had a distributional effect on population patterns over and above pure supply-induced impact.

However, as we have found here, BART's aggregate effect on residential prices and rents has been slight, and consequently could not have exercised any major

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42. Henry O. Pollakowski, "The Effects of Property Taxes and Local Public Spending on Property Values: A Comment and Further Results," Journal of Political Economy 81 (1973), pp. 994 - 1,003.

43. Herbert Mohring, "Land Values and the Measurement of Highway Benefits," Journal of Political Economy LXIX (1961), pp. 236 - 249; D. M. Grether and Pieter Mieszkowski, "Determinants of Real Estate Values," paper prepared for the Cowles Foundation for Research in Economics, Yale University, 1971 (unpublished); K. C. Koutsopolous, "The Impact of Mass Transit on Residential Property values," Annals of the Association of American Geographers 67 (December, 1977), p. 567, note 19.

impact on location patterns. In fact, this is the same conclusion reached in those studies of this project which specifically focused on location decisions and development patterns.[44]

Office rents, in contrast, were found to be influenced by proximity to a BART station. The Study of Development Patterns also concluded that BART had affected employment growth in its station areas, in particular in the central areas of San Francisco and Oakland (which probably applies primarily to office employment).[45] However, whether the increases in rents near the stations actually deterred potential development in these areas is doubtful. The office rental markets being very competitive, the marginal cost of a particular location probably reflects the marginal value of that location. Thus, although a station area location might command a premium in rents, there are also offsetting benefits from such a location.

In sum, we conclude that BART's effects on property prices and rents probably did not have any significant impact on development patterns.

H. DISTRIBUTIONAL EFFECTS ON PROPERTY PRICES

A public improvement project such as BART can be expected to affect the prices of nearby property. The theoretical issues involved, except for distributional aspects, have already been discussed in Section 2.B., above.

An improvement in a region's transportation network increases the supply of land within given commute distances or time intervals.[46] In the absence of any increases in aggregate demand, a uniform improvement in access would then

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44. John Blayney Associates/David M. Dornbusch & Company, Inc., Study of Development Patterns (Berkeley: BART Impact Program Land Use and Urban Development Project Working Paper, 1978); and John Blayney Associates/David M. Dornbusch & Company, Inc., Study of Households' Location Decisions (Berkeley: BART Impact Program Land Use and Urban Development Project Working Paper, 1978).

45. Ibid., p. 72; and John Blayney Associates/David M. Dornbusch & Company, Inc., Study of Employers' Locational Decisions (Berkeley: BART Impact Program Land Use and Urban Development Project Working Paper, 1978).

46. This basic concept was put forward already in 1927 in Robert Murray Haig, "Major Economic Factors in Metropolitan Growth and Management," Regional Plan of New York and Its Environs (New York, 1927). More recent writings on the subject include William Alonso, Location and Land Use (Cambridge: Harvard University Press, 1964), and Louden Wingo, Transportation and Urban Land (Washington, D.C.: Resources for the Future, 1961). An excellent synthesis of earlier work is provided in Michael A. Goldberg, "Transportation, Urban Land Values, and Rents — A Synthesis," Land Economics 46 (May, 1970), pp. 152 - 162; and Roger E. Alcaly, "Transportation and Urban Land Values: A Review of the Theoretical Literature," Land Economics 52 (February, 1976), pp. 42 - 53.

mean a decrease in land prices per square foot at any given distance from the center. However, if the demand for land is price elastic, the price per lot need not fall; it may indeed increase if the reduction in price per unit area is more than compensated for by an increase in the size of the lot purchased. Nevertheless, profits or economic rent must decrease, ceteris paribus, because of the increased competition.

The Study of Development Patterns concludes that BART has not increased the population growth in the three counties it serves compared to the rest of the Bay Area.[47] It is therefore reasonable to assume that there has been no geographical shift in the aggregate, effective demand for housing. However, the perceived improvement in accessibility was not uniform but concentrated along corridors served by BART. Therefore, while aggregate prices per unit area may have decreased in any given commute time category, in response to the increased supply, they increased in those geographical locations enjoying reduced commute time (those served by BART) and decreased more than the average in others--namely, where there was no BART service. In other words, the advantage of being located a certain commute time from the center relative to a location further away lost some of the marginal value when BART increased the supply of land at that very commute time. Simultaneously, decreased commute time (or distance) at certain locations increased their values.

We therefore conclude that from a theoretical point of view property prices per unit area have decreased on the average, but there have been shifts in the geographical distribution of prices so that the areas now served by BART gained and those not served lost, at least relatively. However, as the findings of this study show, the actual BART-induced price changes have been small and limited to rather small areas around some of the stations.

BART increased the total amount of land which is within a feasible commute distance by converting agricultural land to marginal urban land at the fringe of the existing metropolitan area. Whether this increase was enough to offset the theoretical decline in the aggregate worth of properties within the existing area due to the increased supply was not investigated.

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47. John Blayney Associates/David M. Dornbusch & Company, Inc., Study of Development Patterns, op. cit., p. 72.

4. POLICY IMPLICATIONS

Although this study has shown that there have been only small, or even no, BART impacts on aggregate residential prices and rents, it does not imply that this is a general rule. On the contrary, the impact on office rents shows that when other developments enhance the BART effect, mass transit improvements can have substantial impacts. Cases in point here are the Market Street beautification project and the shift in demand towards Market Street, the redevelopment in downtown Oakland, and zoning allowing taller structures near the station in Walnut Creek.

The widely anticipated negative effects of proximity to the BART tracks have either not been perceived or have not been strong enough to depress property prices or rents. This is especially the case where BART's addition to ambient noise and visual intrusion is only marginal. Overflowing parking and increased automobile traffic near some stations, however, have had significant negative effects on neighboring properties and their prices. As BART patronage from stations with such parking problems continues to be high, the possibility exists that even without huge parking lots, BART use might be high, especially where BART provides a substantial improvement in accessibility compared to available alternatives (e.g., Walnut Creek).

These conclusions seem to suggest that if maximal property value impact is the objective, a mass transit system ought to be designed so as to minimize station area overflow parking and automobile traffic in the vicinity and, since the local BART effect diminishes rapidly, to encourage higher densities within walking distance of the station. This would seem to call for a greater emphasis in station designs on the management of nearby traffic flows. Clever use of air rights could both overcome certain negative aspects of parking and allow for higher densities and multiple use right next to, or above, a station.[48] An extensive feeder bus service would transport patrons from outside walking distance.

Value capture has been suggested not only as a means of transferring the value of a public project back to the society, but also as a possible vehicle for financing such projects. Clearly, the impacts detected by this study would not have sufficed for financing a project the scale of BART. However, if financing were an objective, the design of the system would have to differ from that of BART, as indicated above, to maximize use of the potentials to increase property values. Moreover, from a value-capture standpoint, it would probably also be more advantageous for the society to acquire as much as possible of the land near future stations before prices start to soar, and then gradually lease the land at rates which capture the marginal benefit created by the transit service. Careful coordination between physical design and land use management can enhance significantly the positive effects (as they express themselves in increased property prices and rents) of a transportation improvement.

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48. Examples of such designs are the metro systems in Washington, D.C., Toronto, and Stockholm, or, to take a non-metro example, the Golden Gate Redevelopment Project or the Alcoa Building, both in San Francisco.

THE NO-BART ALTERNATIVE

The No-BART Alternative, as defined by the MTC, assumes only incremental improvements in the region's transportation system, with no major highway construction nor any major new transit routes.[49] None of the effects studied here —proximity to stations and tracks—would therefore be present in this alternative. Property prices and rents might nevertheless have increased in areas with relatively good bus transit access, especially if out-of-pocket and/or economic costs of alternative modes of transportation increased substantially. Concentrations of price and rent changes around station areas would, of course, not exist under this alternative.

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49. Metropolitan Transportation Commission, "Rationale and Specifications for the No-BART Alternative" (Berkeley: BART Impact Program LUUD Project Working Note, 1976) (mimeo).

APPENDIX A. ANALYSIS OF EIGHT BART STATION AREAS

A. GENERAL

This appendix presents multiple regression analyses of observed changes in property prices and rents at eight different study sites; several of the sites served as multiple case study areas. Changes in residential property prices[1] were studied at four sites, changes in residential rents at two sites, changes in office rents at three sites, and changes in prices for small commercial property at one site.

The analyses can be characterized as before/after studies: the prices or rents in a period after the event under study are compared to those prevailing before the event. To minimize unwanted variation in the data, it is always the prices or rents of the same properties which were compared over the two time periods; the data represent only bona fide market transactions. Assessors' or others' appraisals were only used to eliminate non-market transactions (e.g., property sales within the family).

All residential sales prices in the analyses are expressed in constant April, 1975 dollars. Each station area has its own deflator index which was obtained by changing the base year of the appropriate, area-specific market value index for single family residences,[2] supplied by the Real Estate Research Council of Northern California. The RERCNC indices are based upon appraisals. In the case of the two station areas in the Mission District of San Francisco for which a true price index was available, this latter index was used.[3]

The residential rents were likewise deflated to reflect 1975 residential rent levels. For office rents, however, no suitable rent index exists; thus, only the changes in office construction costs could be accounted for by deflating the office rents by an office construction cost index. Moreover, unlike the residential price indices, the rent and the construction cost indices exist only for the San Francisco Bay Area as a whole. The construction cost index was obtained from RERCNC's quarterly reports.

Strictly speaking, the changing of base year is applicable only if the index num-

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1. Mainly single family residences, except in the Mission area of San Francisco where a few multiple residential units are included in the samples.

2. These indices are average price relatives published quarterly in the Northern California Real Estate Report, by the RERCNC.

3. Marcy E. Avrin, "Some Economic Effects of Residential Zoning in San Francisco," Center for Research in Economic Growth, Department of Economics, Stanford University, 1977 (Reprint No. 159). Ms. Avrin's indices are hedonic indices constructed by using an OLS regression technique for combining price relatives. They are divided into four subgroups by price class; a weighted average of these indices was computed and used here.

bers satisfy the circular test. Likewise, deflating time series is mathematically proper only when the index numbers meet the time reversal test. The indices used here, being price relatives, meet both tests. Denote the average price paid, or index, for year t by P_t. Then, if any two years are reversed, the corresponding price relatives are reciprocals of each other:

$$\frac{P_i}{P_j} \cdot \frac{P_j}{P_i} = 1$$

Similarly, for any number of price relatives, the following circular property holds:

$$\frac{P_i}{P_j} \cdot \frac{P_k}{P_i} \cdot \frac{P_j}{P_k} = 1$$

and any kind of chaining of the indices is possible.

Despite the fact that the indices employed here have desirable technical properties, problems may still remain. All indices are computed for certain areas. If the area is too large, the index does not adequately reflect local conditions. If the area is too small, deflating market transactions by the index may "wash" away exactly the local conditions (e.g., BART's impact) one wants to investigate. Finally, even if recognized, the researcher cannot always strike an optimum balance between these two opposing tendencies; he has to make do with what indices are available. In this study, an incorrect index (in terms of the area it covers) would affect only the constant term in the model, since all market transactions in any given study area are deflated by the very same index series. Thus, extra caution is urged in interpreting the numerical magnitudes of the constants in the following estimated regression equations, or the relationships of the graphed curves to the horizontal, zero-change line in the figures of the preceding chapters.

In most instances, the data permitted us to distinguish three time periods: before, during, and after BART construction. Three different before/after analyses are therefore possible: (1) Before/During, (2) During/After, and (3) Before/After. The analyses here are labelled accordingly.

The changes from the Before to the During period represent anticipations; BART services had not yet begun but the real estate markets had already started to respond to the anticipated BART benefits. In general, only sales prices are thought to reflect such anticipated benefits; there is much more flexibility in rental arrangements and consequently there is usually no need to pay higher rents until a new benefit is an actuality. Therefore, Before/During analyses were performed only on the data involving sales prices, not rents. The During/After analyses were designed to capture the more immediate effects following the opening of BART service. The Before/After analysis then combines the two previous ones to present the pre-construction, post-construction impact. Although this analysis may smooth out effects, or cancel early impacts with later ones of opposite effect, the Before/After models can be said to represent the

longer-term effects.[4]

The presentations of all station area analyses follow the same format. The station area description, including a brief map of the study area, is followed by the multiple regression analyses and possible key informant opinions. Finally, the information is synthesized and conclusions drawn regarding the effects of BART.

The following notation is used throughout the appendix:

SYMBOL	DESCRIPTION
S1	Sales price in the before period, in 1975 dollars
S2	Sales price in the after period, in 1975 dollars
S2/S1	Relative change in sales prices
R1	Rent in the before period, in 1975 dollars
R2	Rent in the after period, in 1975 dollars
R2/R1	Relative change in rents
DBS	Distance to the nearest BART station, in feet[5]
DBT	Distance to the nearest BART tracks, in feet
DFR	Distance to the nearest freeway segment, in feet
DFA	Distance to the nearest freeway access point, in feet
DE	Distance to the nearest elementary school, in feet
DEFCT	A modified χ^2-distribution of DE: DX = DE/100 DEFCT = $(DX^3)\exp(bDX + cDX^d)$; the parameters b, c, and d are determined for each site separately to yield such local maximum and minimum values for the function that the closest possible fit with the empirical data is obtained. In most instances, however, this function did not reduce the residual variance appreciably and was therefore dropped from the model.
YR1	Year of the observation in the before period
YR2	Year of the observation in the after period
Y2/Y1 =	YR2 - YR1
DP	Distance, in feet, to nearest public park
COR =	1 if property located on a corner 0 otherwise

4. Of course, BART has not been in full operation for more than four years now, so genuinely long-term impacts cannot be investigated.

5. The distances used throughout are straight-line distances, in feet, measured from the frontage of the property to the nearest point of the object in question.

DM		Distance, in feet, to Mission Street, San Francisco
MISS	=	1 if property located on Mission Street 0 otherwise
DS		Distance, in feet, to nearest shopping
YRB		Calendar year building built
AGE 78 - YRB	=	Current age of building
MA	=	1 if property located on Market Street, San Francisco 0 otherwise
OPAR		Number of parking spaces on the premises
APAR		Number of parking spaces in adjacent buildings or lots
PAR	=	OPAR + APAR
SQFT		Size of lot, in square feet

Under each regression coefficient estimate appears the corresponding t-statistic for the null hypothesis that the coefficient is equal to zero. A star appended to these statistics indicates that the coefficient is stable, i.e., differs from zero with a probability of .95.[6] Even variables with non-significant coefficients have been included in some of the regressions either because the variable is of considerable a priori interest (e.g., 1/DBS) or it appears to be multicollinear with one or more of the other explanatory variables.

Following the estimated regression equations are certain summary statistics useful in evaluating the econometric "quality" of the model at a given site:

r	Simple correlation coefficients
N	Number of sample points
R^2	Coefficient of Multiple determination; it expresses the proportion of the original variances which is "explained" by the estimated model
DW	The Durbin-Watson statistic for auto-correlation; a star appended to this statistic indicates the hypothesis can be rejected at the 5 percent risk level. No star here means that the Durbin-Watson test is in this case inconclusive.
SER	The standard error of the model
V%	Coefficient of variation which is obtained by dividing SER by the mean value of the function (the dependent variable) and multiplying by 100; V% expresses the relative error of the model, <u>on the average</u>

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6. A 5 percent risk level for rejecting a null hypothesis has been selected for the entire study.

F(df) The F-statistic with the appropriate number of degrees of freedom within the parentheses; a star appended to this statistic indicates that the estimated equation is, on the whole, statistically significant at the 5 percent level of significance.

The estimated correlation matrix of the estimated coefficients is also presented. This information is useful in judging the degree to which multicollinearity might be present among the explanatory variables.

In certain instances, for example, when multicollinearity is present between two variables of great interest, a significance test of the joint distribution of the coefficients is more appropriate than tests of the individual coefficients. Such a test can be derived from the critical region of a set of r variables, including possibly the regression constant dummy, which can be written as[7]

$$\frac{1}{r}(b-\beta)^1 \; V^{-1} \; (b-\beta) \quad > \quad F(r,N-k)(\alpha)$$

where the $r \times 1$ vector $(b - \beta)$ contains the regression of estimates b of the hypothesized parameters β of the variables of interest;

V is the (appropriate segment of) the estimated variance-covariance matrix of the estimated r coefficients;

N is the sample size;

k is the total number of estimated parameters in the equation; and

α is the preselected level of risk.

If the calculated F-value exceeds the critical $F(r,N-k)$ the null hypothesis that $b = \beta$ can be rejected. In the sequel, we shall refer to this test as the "joint F-test."

A Bartlett test, or some other test for homoscedacity, has not been calculated partially because of small sample sizes in some instances but mainly because visual inspections of the remaining error terms never gave reason to suspect heteroscedacity. Similarly, visual inspection of a graphical display of the error term never indicated significant deviations from a normal distribution.

All regression analyses were performed on the U.C. Berkeley CDC 6400 computer utilizing the current version of the TSP (Time Series Processor) program.

Finally, certain sample statistics are presented. The sample mean value and the standard deviation of the variables included in the estimated model are given along with the average year of the before and after periods.

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7. E. Malvinaud, Statistical Methods of Econometrics (Amsterdam: North Holland Publishing Company, 1966), p. 203.

B. RESIDENTIAL PROPERTY PRICES

El Cerrito Plaza

The El Cerrito Plaza BART station serves the southern part of El Cerrito and Albany, which lies to the south of the station. Both cities consist primarily of older-stock residential units with commercial development confined to the major thoroughfares. El Cerrito Plaza, a community shopping center with adjacent professional office buildings, lies immediately to the southwest of the BART station area.

A mixture of small apartment buildings and single family residences lies west of the BART tracks. On the east side, single family residences predominate. The BART tracks here are elevated and parallel to existing railroad tracks.

The area is predominantly residential. Most commercial activity in the area occurs along San Pablo Avenue. Well to the south of the BART station, Solano Avenue is another major commercial street. A limited amount of commercial activity occurs on Central Avenue, west of San Pablo.

PERIOD: BEFORE/CONSTRUCTION

Insufficient data for statistical analysis.

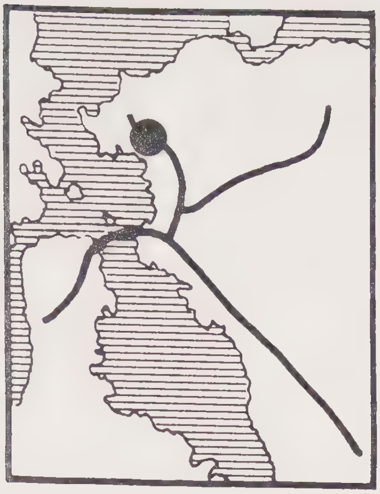
Domain: 675 < DBS < 1 725; 159 < DBT < 1 650

PERIOD: CONSTRUCTION/AFTER
1967...1971 1972...1977

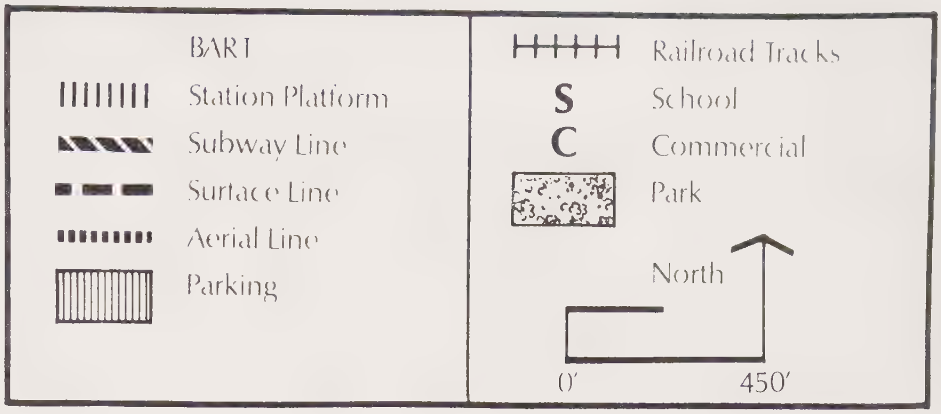
S2/S1	=	1.342	- 62.883(1/DBS)	+ 2.970(1/DBT)	- .282E-4(SQFT)	- .0271 (DEFCT)
t		10.732*	-.855	.109	-1.213	-1.804*

N = 34
R^2 = .216
DW = 2.048*
SER = .123
V% = 11.8
F(4,29) = 1.996

Domain: 525 < DBS < 3 075; 150 < DBT < 3 075



EL CERRITO PLAZA



Residential Property Prices -- El Cerrito Plaza

Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	1/DBT	SQFT	DEFCT
1/DBS	1.000	.759	.024	.073
1/DBT		1.000	.167	.082
SQFT			1.000	-.087
DEFCT				1.000

Although 1/DBS and 1/DBT are positively correlated, the insignificance of these two variables in the above relation is not due to multicollinearity. Like their individual distributions, their joint distribution does not differ significantly from zero-zero;[8] the joint F-test yields $F(4,29) = .710$ which is less than the critical value for the F-distribution with (4,29) degrees of freedom at the 5 percent risk level.

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
S2/S1	..	1.041	.128
S1	$	37 749	10 475
S2	$	39 328	11 947
DBS	feet	1 657	817
DBT	feet	1 403	928
SQFT	sq.ft.	4 034	944
DE	feet	973	468
DEFCT	b = -21.8655	c = 20.866	d = 1.01
	max at DE = 1 000		
	min at DE = 2 000		
YR1	cal. year	69.2	1.2
YR2	cal. year	74.4	1.75
Y2Y1	years	5.2	1.8

PERIOD: BEFORE / AFTER
1960...1966 1972...1977

$$
\begin{array}{llllll}
S2/S1 & = & -.977 & + 16.1395(1/DBS) & + 12.556(1/DBT) & - .313E\text{-}5(S1) \\
t & & -1.051 & .294 & .839 & - .989 \\
 & & + .354\,(DEFCT) & & & \\
 & & 2.140^{*} & & &
\end{array}
$$

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8. I.e., that neither of the two coefficients differ significantly from the value zero.

Residential Property Prices -- El Cerrito Plaza

N = 19
R^2 = .347
DW = 2.379*
SER = .0970
V% = 9.9
F(4,14) = 1.856

Domain: $525 \leq DBS \leq 2\ 325$; $150 \leq DBT \leq 1\ 650$

Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	1/DBT	S1	DEFCT
1/DBS	1.000	.258	-.090	.055
1/DBT		1.000	.346	.26
S1			1.000	.150
DEFCT				1.000

Again, a joint test of the significance of the multicorrelated coefficients of 1/DBS and 1/DBT does not indicate that their joint distribution would differ significantly from zero-zero; the calculated F(4,14) is as low as .492.

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
S2/S1	..	.983	.103
S1	$	37 509	7 782
S2	$	36 868	8 503
DBS	feet	1 078	444
DBT	feet	767	419
DE	feet	1 036	289
DEFCT	b = -21.8655	c = 20.866	d = 1.01
	max at DE = 1 000		
	min at DE = 2 000		
YR1	cal. year	64.4	1.3
YR2	cal. year	73.4	1.5
Y2Y1	years	9.05	1.9

Remarks

There appears to have been a remarkably low turnover of single family residential property around the El Cerrito Plaza BART station. In addition, the Contra Costa Assessor's data on transactions before 1967 are very sporadic. Consequently, our sample sizes are very small in spite of the fact that all repeat market

transactions recorded with the Contra Costa Assessor's Office were included in the samples.

In addition to the variables included in the above estimated equations, the distances to San Pablo Avenue and to the El Cerrito Plaza shopping center were also included in the initial analyses but failed to show statistically stable results. A systematic change in the definition of the last year in the Before Period to include years in the Construction Period likewise failed to produce statistically significant BART effects. Finally, a separate analysis of 13 repeat sales in the period 1973. . .1977, i.e., since BART opened for service, did not show any statistically significant BART impacts.

These results, along with those obtained in the Environmental Impact Project of the BART Impact Program,[9] lead us to conclude that neither the BART station nor the elevated tracks in the El Cerrito Plaza area had any appreciable effect on residential property prices. Suggested reasons for this are:

1. The El Cerrito Plaza shopping center was already in existence before the BART station was built next to it. Thus, the area was already accustomed to a fair amount of automobile traffic, on one hand, and increased property prices due to proximity to the shopping center and the related AC bus service, on the other hand. The inclusion of distance-to-shopping variable in the regressions did not produce statistically significant results which tends to support the above reasoning that the shopping center had already had its impact on property prices in the neighborhood.

2. BART patronage at the El Cerrito Plaza station is relatively low, reflecting low appreciation of BART services in the area.

3. The BART tracks which are elevated in the area are parallel to an existing, and active, railroad track at grade. Thus, the marginal increase in noise and other adverse impacts due to the BART tracks is small. The situation is the same in South Hayward where the analysis results are analogous.

The above explanations generally agree with the findings of the Environmental Impact Project.[10]

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9. DeLeuw, Cather & Company, Responses of Nearby Residents to BART's Environmental Impacts (Berkeley: BART Impact Program Environmental Impact Project Technical Memorandum, 1977), pp. 29, 30; various.

10. Ibid.

Glen Park, San Francisco

The Glen Park District is an older residential area of San Francisco. The BART line here is under ground. Several major traffic arteries (I-280, San Jose Avenue, Alemany Boulevard, and Mission Street) run through the relatively flat southern end of the district. Glen Canyon Park and Glen Park Recreation Center at the northwest corner of the area are large recreational areas serving the neighborhood.

The construction of many new, high quality town houses along the northern edge of Glen Park constitutes the largest recent land-use change. These townhouses were built within the City's Diamond Heights redevelopment area and are occupied by a socially integrated mix of middle to upper income families.

Non-residential activity in the area is limited to neighborhood commercial development. Some strip development is found along the major corridors, but the center of the local commercial activity is a one- to two-block area adjacent to the BART station. This local commercial center predates BART, but has been increasingly active in recent years. There are few offices in the area.

Before BART the area had relatively poor transit access to downtown San Francisco. Now many people drive to the Glen Park BART station and then take BART to the downtown. Since there is no parking lot for BART, commuters park their cars on the streets, making parking scarce. The BART-related traffic also adds to the traffic generated by local stores and the nearby freeways. Traffic congestion and the lack of parking near the BART station is therefore a major issue in Glen Park.

PERIOD: BEFORE / CONSTRUCTION
1962...1967 1967...1972

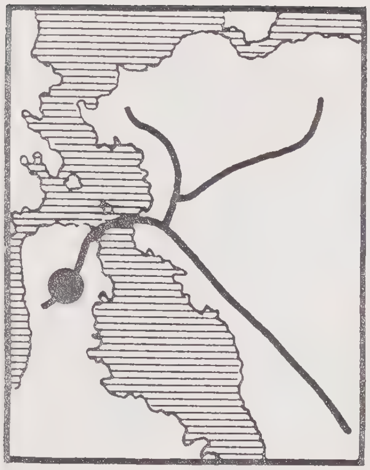
S2/S1 =	1.267 +	25.882(1/DBS) -	.756E-5(S1) +	.454E-3(DEFCT)
t	25.249*	1.795*	- 5.161*	2.334*

N = 85
R^2 = .303
DW = 2.248*
SER = .127
V% = 12.2
F(3,81) = 11.747*

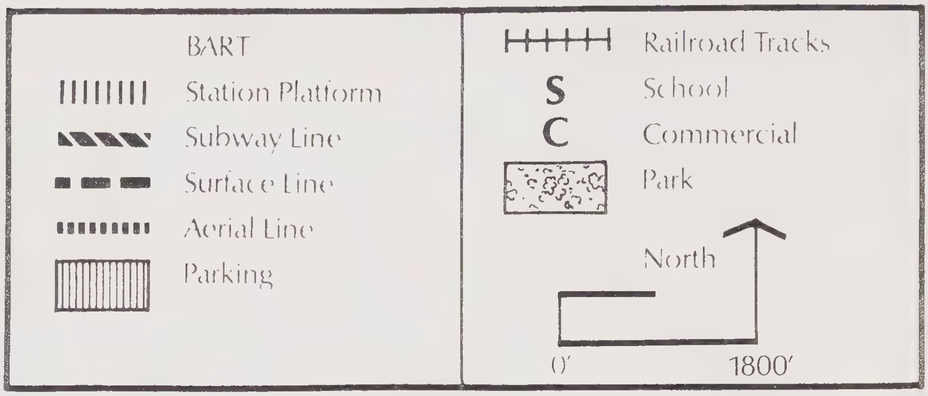
Domain: $150 \leq DBS \leq 2\,650$

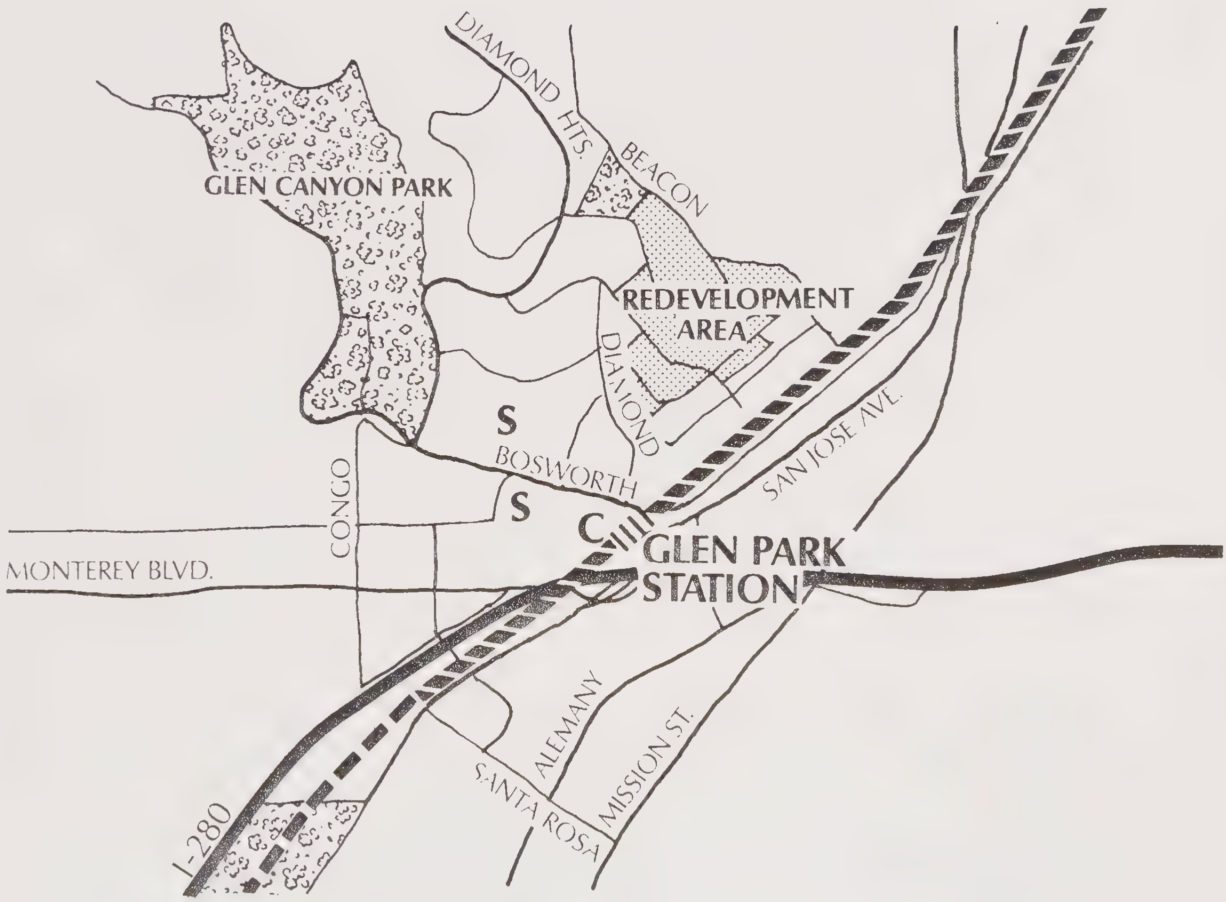
Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	S1	DEFCT
1/DBS	1.000	.275	.008
S1		1.000	.110
DEFCT			1.000



GLEN PARK DISTRICT, SAN FRANCISCO





Residential Property Prices -- Glen Park

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
S2/S1	..	1.039	.148
S1	$	34 094	9 851
S2	$	35 424	..
DBS	feet	1 496	651
DE	feet	1 117	838
DEFCT	b = -.600	c = .00833	d = 2
	max at DE =	600	
	min at DE =	3 000	
YR1	cal. year	64.2	1.4
YR2	cal. year	69.7	1.4
Y2Y1	years	5.55	1.8

PERIOD: CONSTRUCTION/AFTER
1967...1972 1972...1977

$$S2/S1 = 1.374 - 19.400(1/DBS) - .524E\text{-}5(S1) - 4.540(1/DFR)$$
$$t \quad 31.848^* \quad - 1.736^* \quad -4.656^* \quad - 4.204^*$$

N = 89
R^2 = .377
DW = 1.783*
SER = .131
V% = 11.4
F(3,85) = 14.375*

Domain: $100 \leq DBS \leq 2\ 600$

Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	S1	1/DFR
1/DBS	1.000	-.027	.082
S1		1.000	.002
1/DFR			1.000

Residential Property Prices -- Glen Park

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
S2/S1	..	1.150	.157
S1	$	34 184	12 360
S2	$	38 515	12 479
DBS	feet	1 360	625
DFR	feet	932	795
YR1	cal. year	69.3	1.3
YR2	cal. year	74.4	1.7
Y2Y1	years	5.1	2.2

PERIOD: BEFORE / AFTER
1962...1967 1972...1977

$$S2/S1 = \underset{27.827^*}{1.143} + \underset{.305}{3.6885(1/DBS)} - \underset{-2.575^*}{.224E\text{-}5(S1)} - \underset{-2.848^*}{8.199(1/DFR)} + \underset{1.942^*}{14.009(1/DP)}$$

(t values shown beneath the coefficients)

N = 126
R^2 = .152
DW = 2.192*
SER = .162
V% = 15.4
F(4,121) = 5.419*

Domain: $100 \leq DBS \leq 2\ 650$

Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	S1	1/DFR	1/DP
1/DBS	1.000	-.075	.299	-.120
S1		1.000	.013	-.037
1/DFR			1.000	-.139
1/DP				1.000

Residential Property Prices -- Glen Park

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
S2/S1	..	1.053	.172
S1	$	38 003	16 657
S2	$	39 397	15 773
DBS	feet	1 365	553
DFR	feet	970	735
DP	feet	1 463	735
YR1	cal. year	64.3	1.5
YR2	cal. year	74.5	1.6
Y2Y1	years	10.2	2.2

Remarks

Although the chosen variables do not "explain" much of the empirical variation in the data, the estimated coefficients are stable. Neither multicollinearity, autocorrelation, nor heteroscedacity seem to cause any concerns here. The following conclusions therefore seem appropriate.

Proximity to the Glen Park BART station had a small, yet statistically significant, positive effect on property prices during the time period when the expectations vis-a-vis BART service were still high, i.e., just before service began. Judging from discussions with officials with the San Francisco Assessor's Office, the magnitude of the coefficient is reasonable. Since the construction of BART, this positive effect has disappeared as expectations of BART service declined. The fact that proximity to the BART station actually exhibits a negative effect on nearby properties in the Construction/After analysis is probably due more to the increased automobile traffic (and increased sensitivity to various forms of automobile pollution) in the immediate vicinity of the BART station than to BART itself. The BART station is adjacent to a freeway underpass and to a neighborhood shopping area which has enjoyed increased popularity during recent years. The significant negative coefficient of the proximity to the Interstate 280 freeway and to the old San Jose Avenue, which is a high speed expressway, supports the interpretation that residents have become increasingly sensitive to automobile traffic and noise, and/or that the traffic and noise have increased during this period.

However, the constant remains significant and larger than unity in each of the models. Since the deflator index used here reflects the general housing price movements in southwest San Francisco, the Glen Park neighborhood seems to have appreciated more than the surrounding area. Whether or not this is due to the increased mobility offered by BART cannot be determined from the present analysis, but two key informants in the San Francisco Assessor's Office thought that this would be the case.

16th & Mission Streets

In the Mission District of San Francisco BART operates underground. The more northerly of the two stations serving the Mission District is at 16th Street and Mission. This station area presently contains a mixture of industrial, commercial and residential land uses. Activities outside of the station area are causing some instability there. According to a City Planning department official, residents fear office construction will spill over from the downtown, or that the area will become a new skid row.[11] On one hand, there has been a recent upswing in office construction in the vicinity of the Civic Center, just north of the 16th Street station area. But at the same time, demolition by the Yerba Buena Center project of the old "Tenderloin" area has caused an influx of street-people into the 16th Street station area and created some concern. There have also been a number of fires in the area, many suspected to be arson. As a consequence of all this, the area is very labile but the direction of a possible change in the character of the area is uncertain. This is reflected in the uneasiness of the real estate market in the area.

Residential units consist primarily of older stock, low-density single-family and duplex row houses. Apartments and flats tend to be small, in the three- to nine-unit range. The greatest concentrations of residential units occur southwest of the BART station and to the west, towards Dolores Street.

Industrial manufacturing and warehousing uses intrude upon the northern and western sections of the District, but the centers of such activities lie outside the Mission District. Most of these buildings, too, are old and may be approaching obsolescence.

Commercial activity is found on most of the major thoroughfares, with Mission Street being the busiest of these. There are currently only a few scattered office buildings in the area.

PERIOD: BEFORE / CONSTRUCTION
1962...1965 1967...1971

S2/S1	=	.953	+ 11.789(1/DBS)	+ 5.871(1/DM)	+ 82.855(1/DFR)	- .026(Y2Y1)
t		7.291*	.249	1.692	1.675	-1.262

N = 29
R^2 = .226
DW = 1.910*
SER = .216
V% = 23.8
F(4,24) = 1.751

Domain: $225 \leq DBS \leq 1\,700$

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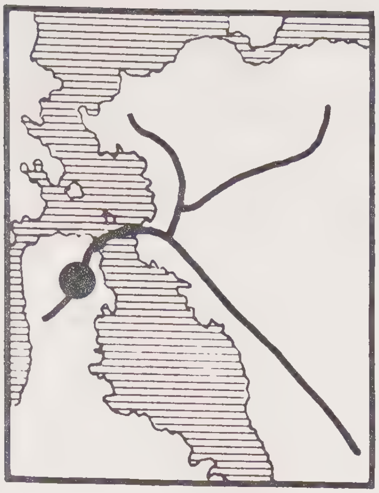
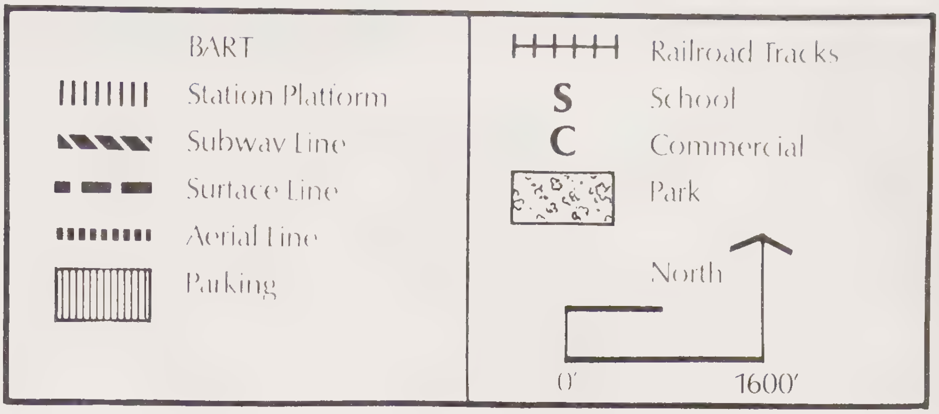
11. Robin Jones, San Francisco Planning Department, 8 February 1978.

MISSION DISTRICT, SAN FRANCISCO





Estimated Correlation Matrix of the Estimated Coefficients:

	1/DBS	1/DM	1/DFR	Y2Y1
1/DBS	1.000	.306	.072	.045
1/DM		1.000	-.218	.112
1/DFR			1.000	.273
Y2Y1				1.000

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
S2/S1	..	.908	.223
S1	$	68 605	36 661
S2	$	61 606	35 202
DBS	feet	1 041	451
DM	feet	547	347
DFR	feet	2 139	765
YR1	cal. year	63.1	1.0
YR2	cal. year	68.9	1.7
Y2Y1	years	5.8	2.1

PERIOD: CONSTRUCTION/AFTER
1967...1971 1972...1977

$$S2/S1 = 1.143 - 9.783(1/DBS) - .237E\text{-}5(S1)$$
$$t \quad 7.196^{*} \quad -.112 \quad -1.354$$

N = 32
R^2 = .0595
DW = 2.369*
SER = .304
V% = 30.7
F(2,29) = .917

Domain: $300 \leq DBS \leq 1\ 800$

Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	S1
1/DBS	1.000	-.073
S1		1.000

Residential Property Prices -- 16th & Mission Streets

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
S2/S1	..	.990	.292
S1	$	60 151	30 785
S2	$	57 301	26 038
YR1	cal. year	68.7	1.3
YR2	cal. year	74.7	1.8
Y2Y1	years	6.0	2.4

PERIOD: BEFORE / AFTER
1962...1966 1972...1977

$$S2/S1 = \underset{10.322^{*}}{.898} + \underset{1.513}{80.804}(1/DBS) + \underset{1.185}{.137}(MISS) + \underset{.618}{17.488}(1/DP)$$

$$+ \underset{1.357}{.163}(COR) - \underset{-2.268^{*}}{.196E\text{-}5}(S1)$$

(t values shown beneath coefficients)

N = 57
R^2 = .114
DW = 1.947*
SER = .227
V% = 25.5
F(5,50) = 1.307

Domain: $250 \leq DBS \leq 1\ 800$

Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	MISS	1/DP	COR	S1
1/DBS	1.000	-.123	-.349	-.133	.184
MISS		1.000	-.095	-.295	.376
1/DP			1.000	-.176	.220
COR				1.000	.565
S1					1.000

Residential Property Prices -- 16th & Mission Streets

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
S2/S1	..	.891	.228
S1	$	72 132	44 286
S2	$	62 247	40 744
DBS	feet	1 083	368
DM	feet	649	372
DP	feet	1 651	858
YR1	cal. year	63.5	1.2
YR2	cal. year	74.3	1.6
Y2Y1	years	10.8	2.0

Remarks

The model and the variables of this study, including proximity to a BART station, do not appear to explain any of the variation in residential property prices in the Mission/16th Street station area. Compared to all other study areas, this is extraordinary. A reason for this might be the Yerba Buena Redevelopment Project between the Mission and the downtown area. The demolition of many old structures in the Tenderloin area has pushed out some of the less desirable activities from this area into the 16th Street area. Not only did this apparently account for the areawide decline in property prices, but the effect was also very sporadic or random in terms of our model. As a consequence, the model may not be able to "sort out" a BART effect — if one indeed exists — from the overall, large variance in the price changes. Thus, the effect of BART here remains undetermined.

The above observations are generally confirmed by three key informants in their discussions of the area. One key informant disagreed, believing that there have been substantial increases in rents and land prices in the station area. While this certainly is true in some instances, it is not the overall trend for the area: compared to other nearby areas in the City, real property prices have declined in this part of the Mission. But nothing suggests that this would have a relationship to BART.

24th & Mission Streets

The 24th Street and Mission station is the more southerly of the two BART subway stations serving the Mission District. This station area consists primarily of older residential stock and strip commercial development running along several of the major streets.

Residential units in the area consist mainly of low-density single family and duplex row houses and three- to nine-unit flats and apartments. Some larger apartment buildings also exist, but high-rise apartments are precluded by height limitations that cover most of the district.

Many of the buildings used for commercial activity in this area are older mixed-use buildings with flats or other residential units atop the ground-floor commercial use. Newer commercial development includes an increasing number of fast-food businesses. Most commercial activity is oriented towards the local community.

There are very few offices or industrial buidings in the area. One-third of a mile south of the 24th Street station lies St. Luke's Hospital, accompanied by medical offices and related uses. The San Francisco General Hospital complex lies three-quarters of a mile to the east of the 24th Street station.

The Mission District hosts a variety of ethnic groups. Recently there has been an increasing migration of Latinos into the area, but the Spanish-speaking population still represents a minority of the Mission's population.

PERIOD: BEFORE / CONSTRUCTION
1962...1966 1967...1971

$$\begin{array}{lllllll}
S2/S1 & = & 1.034 & + 108.978(1/DBS) & + .284(MISS) & - 97.410(1/DS) \\
t & & 17.604^* & 2.614^* & 1.672^* & - 2.167^* \\
 & & + .168(COR) & - .108E\text{-}5(S1) & & \\
 & & 1.934^* & -2.524^* & &
\end{array}$$

N = 77
R^2 = .231
DW = 2.072*
SER = .229
V% = 23.1
F(5,71) = 4.260*

Domain: $250 \leq DBS \leq 2\ 800$

Residential Property Prices -- 24th & Mission Streets

Estimated Correlation Matrix of the Estimated Coefficients:

	1/DBS	MISS	1/DS	COR	S1
1/DBS	1.000	.248	.499	-.107	-.043
MISS		1.000	-.125	-.029	-.085
1/DS			1.000	.165	.007
COR				1.000	.031
S1					1.000

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
S2/S1	..	.989	.250
S1	$	66 490	61 009
S2	$	61 963	52 494
DBS	feet	1 434	592
DM	feet	888	467
DS	feet	1 317	608
YR1	cal. year	63.6	1.4
YR2	cal. year	69.1	1.7
Y2Y1	years	5.4	2.2

In evaluating the equation, the correlation between DBS and DS has to be taken into account. The following empirical relationship between the two variables can be utilized:

$$DS = 500.070 + .570(DBS); \quad r = .555$$

PERIOD: CONSTRUCTION/AFTER
1967...1971 1972...1977

S2/S1 =	1.144	- 8.558(1/DBS)	- .350(MISS)	- .139E-5(S1)	+ .0272(Y2Y1)
t	11.398*	-.139	-1.916*	-1.879*	1.906*

N = 101
R^2 = .1055
DW = 2.020*
SER = .309
V% = 25.6
F(4,96) = 2.832*

Domain: $300 \leq DBS \leq 2\ 375$

Residential Property Prices -- 24th & Mission Streets

Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	MISS	S1	Y2Y1
1/DBS	1.000	-.016	.204	-.028
MISS		1.000	.129	.062
S1			1.000	.046
Y2Y1				1.000

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
S2/S1	..	1.204	.318
S1	$	51 181	42 856
S2	$	58 846	48 638
DBS	feet	1 355	503
DM	feet	912	447
YR1	cal. year	69.1	1.5
YR2	cal. year	74.5	1.7
Y2Y1	years	5.5	2.2

PERIOD: BEFORE / AFTER
1962...1966 1972...1977

$$S2/S1 = .711 + 50.124(1/DBS) - .229(COR) - .140E\text{-}6(S1) + .0299(Y2Y1)$$

t: 3.025* .746 -1.896* -2.404* 1.567

N = .145
R^2 = .084
DW = 2.095*
SER = .465
V% = 44.6
F(4,140) = 3.217*

Domain: $250 \leq DBS \leq 2\ 225$

Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	COR	S1	Y2Y1
1/DBS	1.000	.008	.094	-.192
COR		1.000	.011	-.111
S1			1.000	-.017
Y2Y1				1.000

Residential Property Prices -- 24th & Mission Streets

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
S2/S1	..	1.043	.477
S1	$	117 926	664 806
S2	$	60 635	50 171
DBS	feet	1 392	895
DM	feet	809	461
DE	..	749	386
DS	feet	1 245	572
DP	feet	1 789	963
YR1	cal. year	63.7	1.3
YR2	cal. year	74.6	1.7
Y2Y1	years	10.9	2.1

As the large standard deviations of the sales prices in the Before/After analysis show, the sample contains a few very high priced properties, possibly multiple unit structures. To remove these properties from the sample on the grounds that they belong to a different universe (real estate market) would probably not improve the model's performance. It still performs poorly, in terms of explaining the total variance, in the other samples where such high-priced properties happen not to be included.

Remarks

Only in the time period before BART service began did proximity to the BART station show a significant effect in the model. The effect disappeared totally in the period after service started and the longer term effect is likewise insignificant. Although the variables 1/DBS and 1/DS are somewhat multicollinear in the Before/Construction sample, making the rather high estimated value of the coefficient of 1/DBS suspect, it nevertheless appears safe to reject the null hypothesis that BART did not have any positive influence on housing prices in the Mission and 24th Street station area in the period before BART service started; a joint test yields $F(5,71) = 3.912$, enabling us to reject a null hypothesis that both of the coefficients of 1/DBS and 1/DS would be equal to zero.

Thus one can conclude that when anticipations vis-a-vis BART service were relatively high, a location close to the BART station was valued more than a location further away. However, after BART service was initiated and anticipations started to disappear, the additional value due to a location close to the station also started to vanish. This result parallels that of several other station areas. Although all four key informants queried about this area felt that BART had an influence on nearby property prices, only one specifically mentioned that this had occurred "early in the game."

On the whole, the model adopted for this study works least satisfactorily in the Mission area. If the objective were to adequately explain the variance in the changes in property prices here, a totally different model appears necessary. Or, it is also plausible that the real estate market in the Mission is to a large extent characterized by random factors and thus not easily described by a simple, formal model.

South Hayward

The study includes virtually all developed land in the City of Hayward south of Harder Road and Route 92 and east of Hesperian Boulevard. This area is served by the South Hayward BART station. The BART tracks here are at grade and parallel to an existing railroad track.

Residential development covers most of the area. A mixture of apartments and single family dwellings is located in the area northwest of the BART station. Elsewhere, some apartments can be found, but single family residences predominate.

Much of the housing stock just north and east of the South Hayward BART station is of low quality and lacks public amenities such as sidewalks, gutters and streetlights. There is also some low quality dilapidated housing near Folsom Street. Higher quality housing is found north of Tennyson Road and west of the BART tracks and also on the west side of the BART station south of Tennyson.

Commercial activity in this area is primarily limited to strip development along Harder Road, West Jackson Street, Hesperian Boulevard, Tennyson Road and Mission Boulevard. The South Hayward Industrial Park is indicated on the map.

PERIOD: CONSTRUCTION/AFTER
1969...1971 1972...1977

$$S2/S1 = \underset{23.502*}{1.018} + \underset{3.040*}{139.437(1/DBS)} - \underset{-.763}{10.824(1/DBT)} - \underset{-1.787*}{.197E\text{-}5(S1)}$$

$$+ \underset{1.396}{9.400(1/DFR)} - \underset{-3.052*}{38.697(1/DFA)}$$

(t values shown beneath coefficients)

N = 88
R^2 = .2145
DW = 6908*
SER = .0945
V% = 9.8
F(5,82) = 4.478*

Residential Property Prices -- South Hayward

Domain: $1\ 000 \leq DBS \leq 12\ 000$; $200 \leq DBT \leq 1\ 300$

Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	1/DBT	S1	1/DFR	1/DFA
1/DBS	1.000	.353	-.018	-.038	-.016
1/DBT		1.000	-.170	-.145	-.080
S1			1.000	-.081	-.095
1/DFR				1.000	.556
1/DFA					1.000

Sample Statistics:

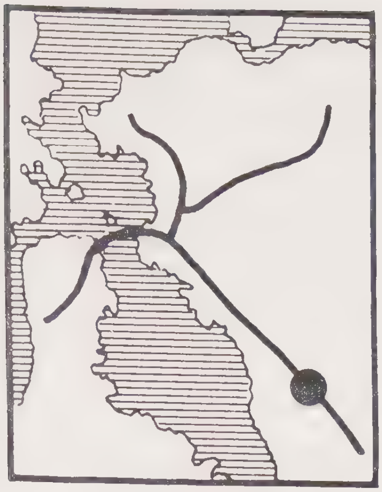
Variable	Unit	Average Value	Standard Deviation
S2/S1	..	.962	.103
S1	$	34 083	9 419
S2	$	32 631	8 420
DBS	feet	7 127	2 563
DBT	feet	4 782	3 054
DFR	feet	4 313	3 772
DRA	feet	4 799	3 544
YR1	cal. year	69.5	1.0
YR2	cal. year	74.6	1.5
Y2Y1	years	5.1	1.6

Remarks

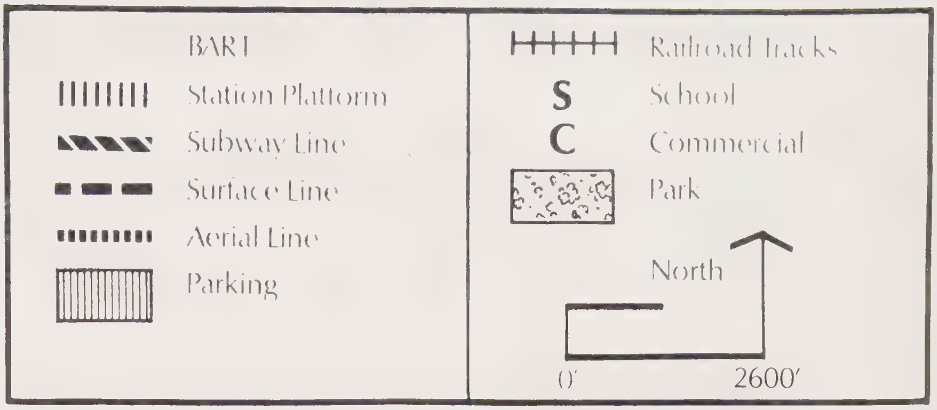
The cooperation of the Alameda County Assessor to obtain property price data could not be obtained. We were therefore forced to use data from the Multiple Listing Service. Although this source is qualitatively good (provided that the final sales price, rather than the asking price, is used), it does not extend back far enough to permit a Before/Construction analysis.

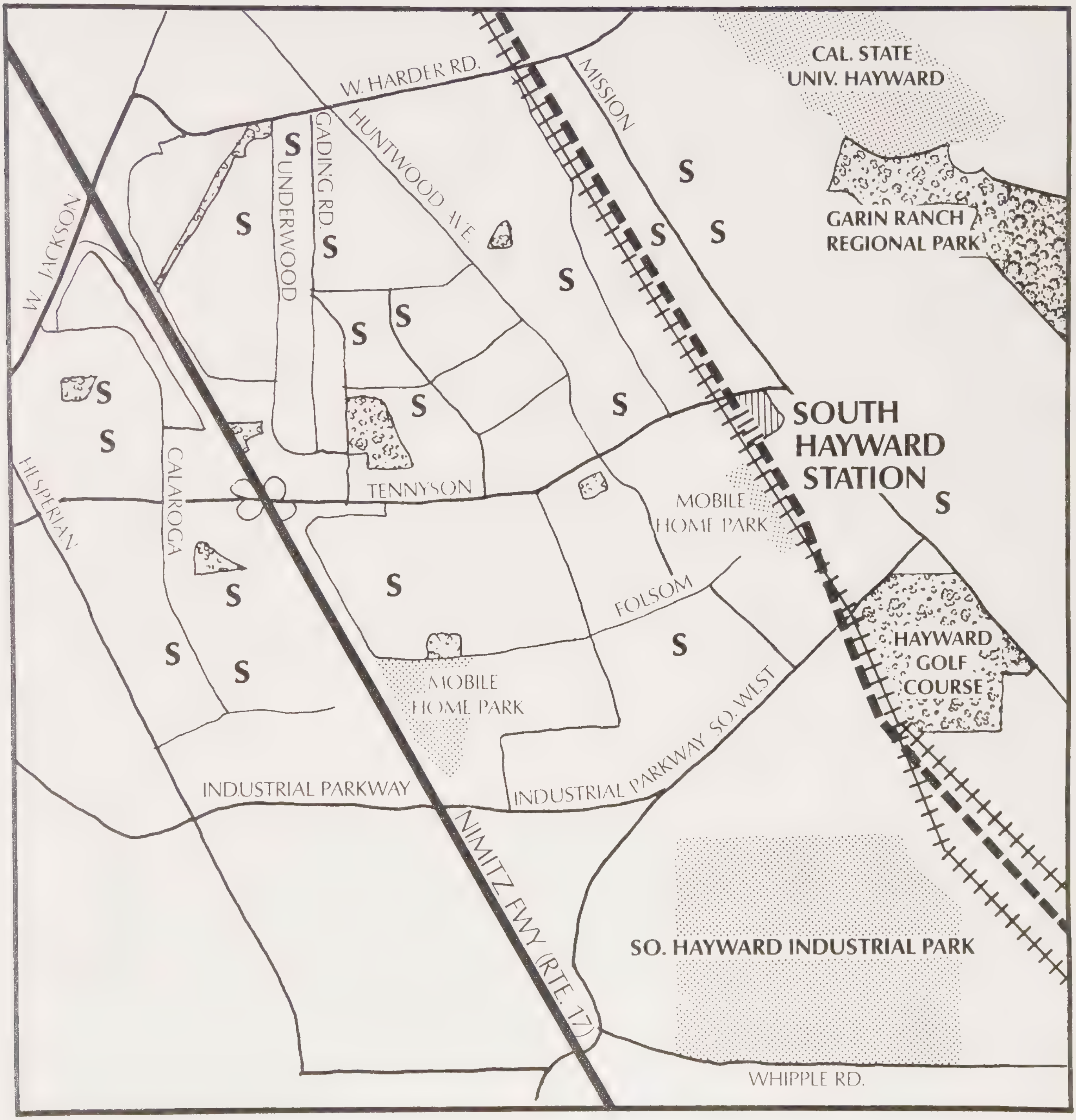
The fact that 1/DBT is somewhat multicorrelated with 1/DBS does not appear to account for the insignificance of the coefficient of 1/DBT; a joint test of the hypothesis that the coefficient of 1/DBS equals 100 and that of 1/DBT equals zero yields $F(5,82) = .490$. That is, the hypothesis that proximity to the BART tracks has had no significant negative effects on property prices while proximity to the station has had a positive impact in South Hayward cannot be rejected.

In calculating the expected value of the function (S2/S1) it nevertheless appears prudent to take into account the positive correlation between proximity to the



SOUTH HAYWARD





BART station and closeness to the tracks. The following linear equation empirically describes that relationship:

$$DBT = 628 + .583(DBS); \quad r = .489$$

At all other study sites we have limited the study area to within at most 4,000 feet from the nearest BART station. In South Hayward, however, we extended the study area to include properties as far as 12,000 feet away from the station to test the assumption that BART's effects did not extend beyond 4,000 feet. The regression results clearly show that BART's effect, although positive and statistically significant, is in absolute terms small and diminishes rapidly. This result has also been observed at other study sites.

We also note that the estimated coefficients of 1/DFR and 1/DFA have unexpected signs. While this does not affect our conclusions with respect to BART, empirical reasons for these unexpected signs may be:

— the homes next to the freeway are in many places in notably better condition than those further away. Proximity to these homes seems to outweigh any possibile disutility from the freeway itself.

— proximity to a freeway access point not only offers good access but also implies much traffic in the neighborhood. Evidently the disutilities outweigh the benefits to the residents in South Hayward.

The key informant opinions concur with the conclusions reached above. Three of the four key informants thought that proximity to BART had a marginal, positive effect on the selling of a property in South Hayward, although one informant expressed the opinion that property backing up to the BART tracks had been difficult to sell. Two of the informants explicitly said that they had no complaint about noise or other disturbances from BART. The situation here is similar to that in El Cerrito: the BART tracks run parallel to the Southern Pacific Railroad tracks, and compared to the railroad trains, BART is quiet.

Walnut Creek

The Walnut Creek BART station is located one mile north of Walnut Creek's downtown shopping area and adjoins Interstate 680 and Ygnacio Valley Road, a major east-west corridor. Although the area is primarily residential, there is sufficient office and retail development to designate Walnut Creek as a regional sub-center for the Central Contra Costa County suburbs.

Residential Property Prices -- Walnut Creek

Land west and north of the BART station is almost exclusively in residential use, except for properties fronting on North Main Street. There are apartment buildings to the north, especially above Geary Road, but single family dwellings predominate. Immediately south of the BART station area and west of California Boulevard lies another residential area, with apartment buildings predominating in the blocks closest to the BART station.

Core area development plans have focused on keeping downtown Walnut Creek competitive with suburban shopping malls by providing increased parking especially in the Broadway Plaza area where the largest amount of retail activity is centered. Office development has occurred in scattered nodes around the periphery of the downtown shopping area. East of the BART station a great deal of development in recent years has centered around Ygnacio Valley Road. The new development extends from the BART station northeast to beyond Oak Grove Road. A major office center has been constructed in the Shadelands property, near the junction of Ygnacio Valley and Oak Grove Roads. Office and retail construction has also occurred near the BART station. Walnut Creek Plaza, the largest office buiding in central Contra Costa County, is directly across from the BART station, and Cost Plus has a new store next door; a new municipal court building is located at the corner of Ygnacio Valley Road and Main Street.

PERIOD: BEFORE / CONSTRUCTION
1960...1967 1967...1971

$$S2/S1 = \underset{41.638^*}{1.165} + \underset{4.617^*}{240.900}(1/DBS) - \underset{2.093^*}{44.784}(1/DBT) - \underset{-2.932^*}{.762E\text{-}6}(S1)$$

t

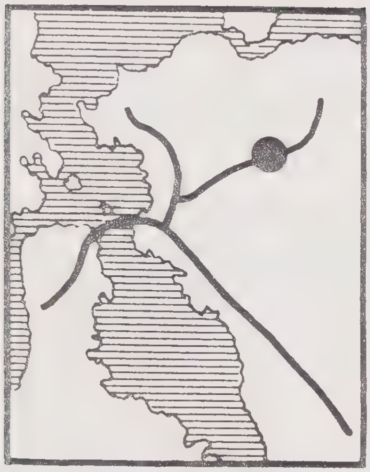
$$- \underset{-.889}{3.395}(1/DFR) - \underset{-4.402^*}{134.889}(2/DFA)$$

N = 37
R^2 = .574
DW = 2.296*
SER = .050
V% = 4.5
F(5,31) = 8.368*

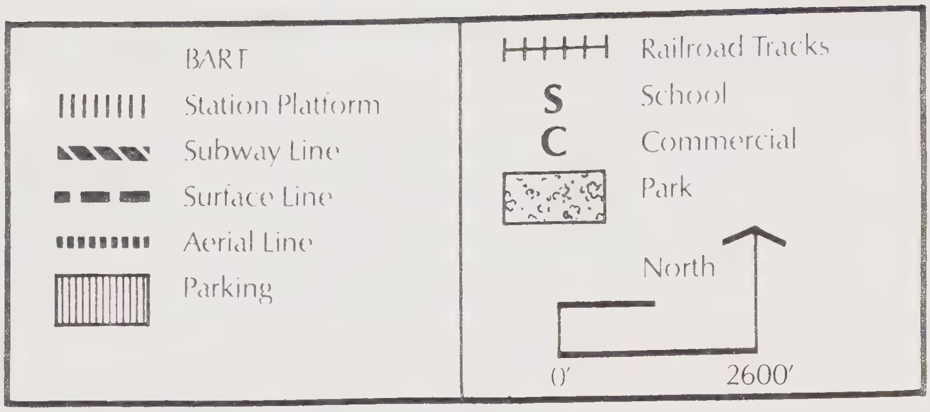
Domain: $825 \leq DBS \leq 3\ 900$; $400 \leq DBT \leq 3\ 900$

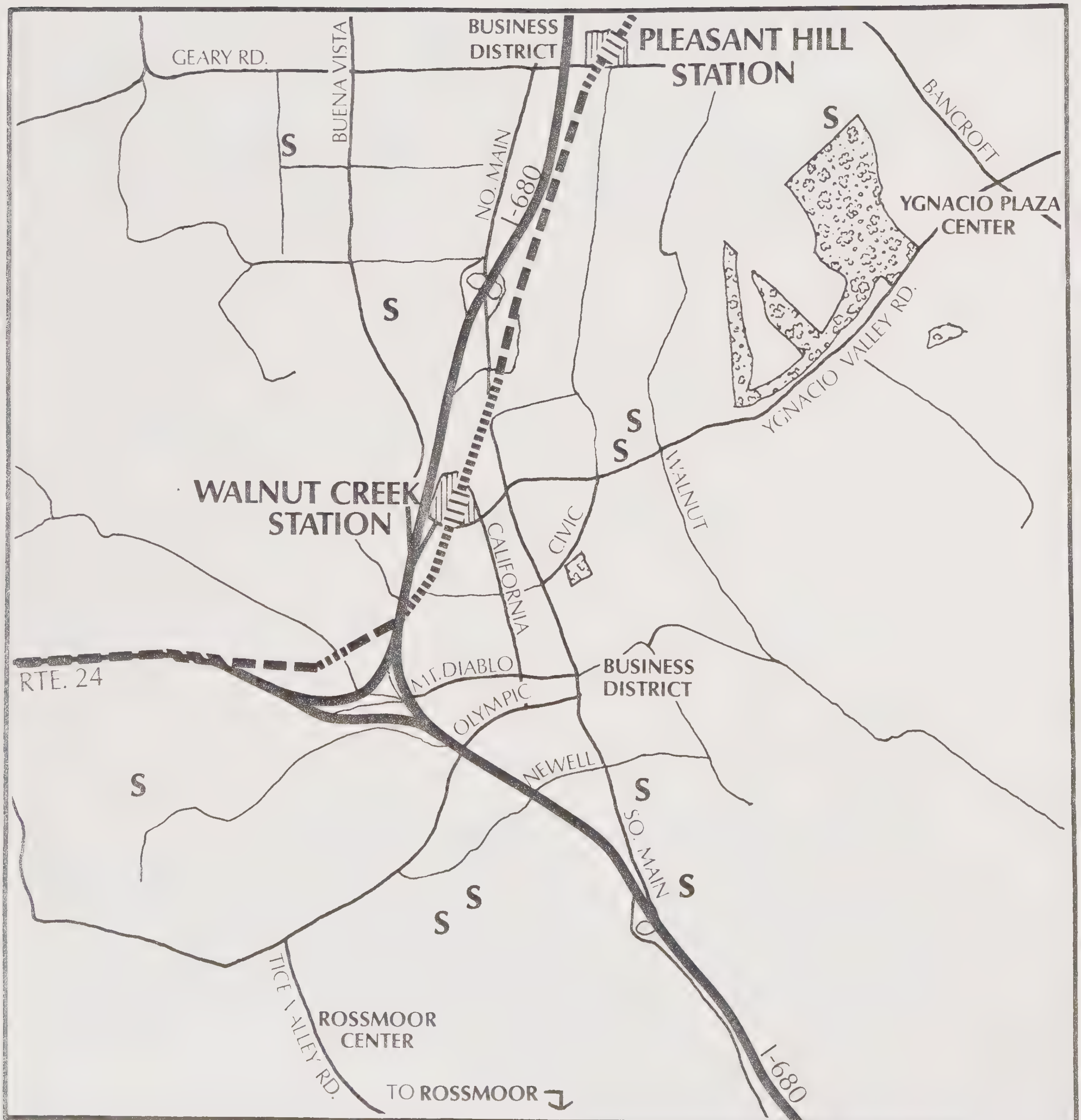
Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	1/DBT	S1	1/DFR	1/DFA
1/DBS	1.000	.267	-.020	-.072	.555
1/DBT		1.000	-.049	.603	.090
S1			1.000	-.073	-.118
1/DFR				1.000	.051
1/DFA					1.000



WALNUT CREEK





Residential Property Prices -- Walnut Creek

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
S2/S1	..	1.105	.0702
S1	$	45 209	32 814
S2	$	50 037	..
DBS	feet	2 321	870
DBT	feet	2 032	1 039
DFR	feet	1 355	794
DFA	feet	1 542	752
YR1	cal. year	63.8	1.7
YR2	cal. year	69.2	1.2
Y2Y1	years	5.4	..

Because the coefficients of 1/DBS and 1/DFA have opposite signs and are multicollinear, it is important to account for their interrelationship at Walnut Creek when calculating expected values for the function (S2/S1). Likewise, the relationship between the BART tracks and the freeway must also be taken into account. Using simple, linear two-variable equations we can substitute the following empirical relationships in the above estimated equations:

$$DFA = 215.871 + .571(DBS); \quad r = .790$$

$$DFR = -46.454 + .690(DBT); \quad r = .902$$

PERIOD: CONSTRUCTION/AFTER
1967...1971 1972...1977

S2/S1 =	1.160	- 89.113(1/DBS)	- 14.886(1/DBT)	- .119E-5(S1)	
t	53.440*	-1.503	-2.004*	-2.959*	
	-2.586(1/DFR)	+ 9.415(1/DFA)			
	-1.091	2.227*			

N = 28
R^2 = .8305
DW = 1.748*
SER = .06065
V% = 6.1
F(5,22) = 21.555*

Domain: $550 \le DBS \le 4\ 200$; $75 \le DBT \le 4\ 200$

Residential Property Prices -- Walnut Creek

Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	1/DBT	S1	1/DFR	1/DFA
1/DBS	1.000	.771	.835	.490	.539
1/DBT		1.000	-.576	.367	.382
S1			1.000	.437	.463
1/DFR				1.000	.094
1/DFA					1.000

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
S2/S1	..	.998	.131
S2	$	66 070	..
S1	$	66 202	5 300
DBS	feet	1 975	1 180
DBT	feet	1 902	1 387
DFR	feet	1 224	1 081
DFA	feet	1 568	1 074
YR1	cal. year	68.9	1.6
YR2	cal. year	73.4	1.8
Y2Y1	years	4.5	..

The heavy multicollinearity among the explanatory variables precludes any inference regarding the individual coefficient estimates. However, all the variables jointly have a significant impact on the dependent variable, as the F for the whole model shows. Consequently, in a joint test including all the variables the hypothesis that the coefficient of 1/DBS equals some value between -50 and -100 could not be rejected.

PERIOD: BEFORE / AFTER
1962...1967 1972...1977

S2/S1 = 1.281 - 114.667(1/DBS) - 11.207(1/DBT) - .178E-5(S1)
t 51.727* -2.382* -2.050* -4.939*

N = 34
R^2 = .749
DW = 2.015*
SER = .0738
V% = 6.7
F(3,30) = 29.777*

Domain: $500 \leq DBS \leq 4\ 050$; $75 \leq DBT \leq 4\ 050$

Residential Property Prices -- Walnut Creek

Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	1/DBT	S1
1/DBS	1.000	.456	.551
1/DBT		1.000	.092
S1			1.000

Distances to the freeway and to freeway access are not significant variables in this sample, nor are they particularly multicorrelated with the variables included.

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
S2/S1	..	1.107	.138
S1	$	51 562	43 118
S2	$	57 078	..
DBS	feet	2 229	1 002
DBT	feet	2 015	1 172
YR1	cal. year	63.2	2.5
YR2	cal. year	72.8	3.6
Y2Y1	years	9.6	..

In evaluating the expected value of the function (S2/S1) for this time period, the multicollinearity among 1/DBS and 1/DBT, and between 1/DBT and S1, again needs to be taken into account. The following linear equations describe their empirical relationships:

$$DBT = -62.088 + .932(DBS); \quad r = .797$$

$$S1 = 80\ 288 - 12.885(DBS); \quad r = -.299$$

These equations can be substituted for the simple variables in the above estimated S1/S2 equation.

Remarks

As in El Cerrito, the rather poor availability of sales data from the period before BART has led to fairly small sample sizes and, moreover, has precluded us from defining our sample frame to break the multicollinearity now present in the data.

The analytical results are in general agreement with a priori expectations and the results at other station areas. However, because of the rather serious multicollinearity here, the coefficient estimates are not only unnecessarily inefficient (their estimated standard errors are large) but they are very sensitive to the particular set of sample data — a different sample might produce remarkably different estimates of the coefficients. Moreover, in interpreting the numerical magnitudes of the coefficient estimates, the sample domain of the variables has to be taken into account. In particular, in the Before/Construction analysis, there are no sample points closer than 825 feet from the station, and none further away than 3,900 feet. Thus, it is quite possible that the rather large positive coefficient of 1/DBS only reflects the downward sloping part of a true function which begins with very low values near the station, peaks out at around 800 feet, and then starts to slope downwards as the distance to the BART station increases. Without further data points, however, this possibility cannot be investigated.

In addition, while the expected value of the estimated equations certainly can be evaluated, taking into account the indicated relationships among the multicollinear variables, for varying distances to the BART station or tracks, the result cannot with any certainty be attributed to BART. We must therefore refrain from making any numerical estimates of BART's effects on residential property prices in Walnut Creek.

However, because of the stability of the estimated coefficients, despite the inefficiency in estimation, and because the analytical results are in agreement with key informant opinions, the following qualitative conclusions appear at least tentatively warranted.

Proximity to the Walnut Creek BART station appears to have had an increasing effect on property prices in the early period when anticipations of BART service were high. At the same time, the fear of adverse effects such as noise and visual aspects caused properties near the BART tracks to decrease slightly in price, but this decrease was overshadowed by the positive effects of station proximity.

The positive effect of proximity to the BART station has since then turned negative. The reversal is probably due to problems of an overflowing BART parking lot and much traffic around the station. An alternative specification of the model to account for the nuisances associated with very close proximity to the station failed to yield statistically stable results, perhaps due to the small sample sizes. The negative effect associated with proximity to the BART tracks has remained but has probably decreased in absolute magnitude.[12]

The longer term effect, depicted by the Before/After analysis, shows a net negative effect of immediate proximity to the Walnut Creek BART station. Closeness to the tracks also continues to affect property prices negatively but only

12. The multicollinearity may have caused the estimates of the standard errors to be biased, thereby preventing us from formally testing the difference between the two coefficients.

marginally so; even as close as 100 feet from the tracks, the price for a typical $75,000 to $80,000 house would only be $8,000 less than if it were located 2,000 feet away from the tracks (these figures are only approximate due to the existing multicollinearity, but they do illustrate the magnitudes involved).

These findings are supported by the key informants. One informant felt that BART had an effect on property prices "at the beginning but the illusion is gone now." Another felt that BART might have had an areawide effect in Walnut Creek but that any effect on properties near the station would probably be marginal, if existing at all. The third key informant did not think "that property prices near the station have been affected, at least not in a positive way."

C. RESIDENTIAL RENTS

Mission District, San Francisco

In the Mission District of San Francisco BART operates underground. For a map of the area, see page 71. The more northerly of the two stations serving the Mission District is at 16th Street and Mission. This station area presently contains a mixture of industrial, commercial and residential land uses. Activities outside of the station area are causing some instability there. According to a City Planning Department official, residents fear office construction will spill over from the downtown, or that the area will become a new skid row.[13] On one hand, there has been a recent upswing in office construction in the vicinity of the Civic Center, just north of the 16th Street station area. But at the same time, demolition by the Yerba Buena Center project of the old "Tenderloin" area has caused an influx of street-people into the 16th Street station area and created some concern. There have also been a number of fires in the area, many suspected to be arson. As a consequence of all this, the area is very labile but the direction of a possible change in the character of the area is uncertain. This is reflected in the uneasiness of the real estate market in the area.

Residential units consist primarily of older stock, low-density single-family and duplex row houses. Apartments and flats tend to be small, in the three- to nine-unit range. The greatest concentrations of residential units occur southwest of the BART station and to the west, towards Dolores Street.

Industrial manufacturing and warehousing uses intrude upon the northern and western sections of the District, but the centers of such activities lie outside the Mission District. Most of these buildings, too, are old and may be approaching obsolescence.

Commercial activity is found on most of the major thoroughfares, with Mission Street being the busiest of these. There are currently only a few scattered office buildings in the area.

The 24th Street and Mission station is the more southerly of the two BART subway stations serving the Mission District. This station area consists primarily of older residential stock and strip commercial development running along several of the major streets.

Residential units in the area consist mainly of low-density single family and duplex row houses and three- to nine-unit flats and apartments. Some larger apartment buildings also exist, but high-rise apartments are precluded by height limitations that cover most of the district.

Many of the buildings used for commercial activity in this area are older mixed-use buildings with flats or other residential units atop the ground-floor commercial use. Newer commercial development includes an increasing number of fast-food businesses. Most commercial activity is oriented towards the local community.

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13. Robin Jones, San Francisco Planning Department, 8 February 1978.

Residential Rents -- Mission District

There are very few offices or industrial buidings in the area. One-third of a mile south of the 24th Street station lies St. Luke's Hospital, accompanied by medical offices and related uses. The San Francisco General Hospital complex lies three-quarters of a mile to the east of the 24th Street station.

The Mission District hosts a variety of ethnic groups. Recently there has been an increasing migration of Latinos into the area, but the Spanish-speaking population still represents a minority of the Mission's population.

PERIOD: CONSTRUCTION/AFTER
1968...1972 1976...1978

R2/R1 =	2.043	+ 6.620(1/DBS)	-6.263(1/DM)	- 335.866(1/DFA)	- .00352(R1)
t	10.710*	.058	-1.069	-1.712*	-3.538*

N = 68
R^2 = .2145
DW = 1.855*
SER = .420
V% = 31.5
F(4,63) = 4.302*

Domain: $225 \leq DBS \leq 2\ 800$

Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	1/DM	1/DFA	R1
1/DBS	1.000	.493	.418	.099
1/DM		1.000	-.144	-.042
1/DFA			1.000	-.490
R1				1.000

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
R2/R1	..	1.335	.456
R1	$/month	164.1	51.8
R2	$/month	209.9	71.3
DBS	feet	1 827	597
DM	feet	1 250	698
DFA	feet	3 931	1 653
YR1	cal. year	71.2	1.3
YR2	cal. year	76.4	.6
Y2Y1	years	5.25	1.5

Remarks

Although multicollinearity appears to be present among the explanatory variables, the standard error of the estimate of the coefficient of 1/DBS is relatively so large that the lack of significance of the coefficient can hardly be blamed solely on multicollinearity. It might also be argued that the present Before period extends too far back in time (to 1968) to observe a BART impact. It is conceivable that renters would be unwilling to pay many years in advance for some future amenity since rental agreements seldom are made for longer than one year. To investigate this hypothesis, all sample points with the initial rent observation before 1972 were dropped, leaving a sample of 42 observations. Proximity to the BART stations continued to remain insignificant and the overall estimated model was, in terms of reduced variance, less satisfactory than the one presented above. Recall also the analyses of changes in residential property prices in the area which showed that only around the 24th Street station was there any BART impact, and then only during the early period (anticipation) when rents were not expected to be affected yet.

Considering the above, it therefore appears reasonable to reject the hypothesis that BART had a positive (i.e., increasing) effect on rents in the Mission.

In general rents have increased in the Mission more than in the region as a whole, as evidenced by the substantial constant factor in the estimated model and the mean value of R2/R1 in the sample. Of the two key informants who mentioned residential rents specifically, one thought that the rent increases had occurred in the entire Mission area whereas the other thought they had increased more, closer to the stations.

Walnut Creek

The Walnut Creek BART station is located one mile north of Walnut Creek's downtown shopping area and adjoins Interstate 680 and Ygnacio Valley Road, a major east-west corridor. Although the area is primarily residential, there is sufficient office and retail development to designate Walnut Creek as a regional sub-center for the Central Contra Costa County suburbs. For a map of the area, see page 84.

Land west and north of the BART station is almost exclusively in residential use, except for properties fronting on North Main Street. There are apartment buildings to the north, especially above Geary Road, but single family dwellings predominate. Immediately south of the BART station area and west of California Boulevard lies another residential area, with apartment buildings predominating in the blocks closest to the BART station.

Core area development plans have focused on keeping downtown Walnut Creek

competitive with suburban shopping malls by providing increased parking especially in the Broadway Plaza area where the largest amount of retail activity is centered. Office development has occurred in scattered nodes around the periphery of the downtown shopping area. East of the BART station a great deal of development in recent years has centered around Ygnacio Valley Road. The new development extends from the BART station northeast to beyond Oak Grove Road. A major office center has been constructed in the Shadelands property, near the junction of Ygnacio Valley and Oak Grove Roads. Office and retail construction has also occurred near the BART station. Walnut Creek Plaza, the largest office building in central Contra Costa County, is directly across from the BART station, and Cost Plus has a new store next door; a new municipal court building is located at the corner of Ygnacio Valley Road and Main Street.

PERIOD: CONSTRUCTION/AFTER
1969...1972 1973...1978

R2/R1 =	1.120	+ .487(1/DBS)	- 20.449(1/DBT)	+ 5.177(1/DFA)	+ .659(1/DFR)
t	10.368*	.012	-.937	.111	.265
	- .433E-3(R1)	+ .016(Y2Y1)			
	-1.722*	1.803*			

N = 48
R^2 = .210
DW = 1.5705
SER = .121
V% = 11.65
F(6,41) = 1.821

Domain: $150 \le DBS \le 12\ 000$; $150 \le DBT \le 11\ 000$

Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	1/DBT	1/DFA	1/DFR	R1	Y2Y1
1/DBS	1.000	.599	.662	-.023	.321	-.285
1/DBT		1.000	.010	-.021	-.125	-.079
1/DFA			1.000	.120	-.528	.254
1/DFR				1.000	-.037	-.202
R1					1.000	-.041
Y2Y1						1.000

Residential Rents -- Walnut Creek

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
R2/R1	..	1.038	.126
R1	$/month	332	87.9
R2	$/month	341	89.2
DBS	feet	5 380	4 021
DBT	feet	3 749	3 100
DFA	feet	3 911	4 116
DFR	feet	3 605	4 189
YR1	cal. year	70.4	1.0
YR2	cal. year	74.9	2.0
Y2Y1	years	4.5	2.1

Remarks

There appears to be substantial multicollinearity among the variables 1/DBS, 1/DBT, and 1/DFA. None of these variables show individual, stable influences on the variance of the dependent variable R2/R1 as can be seen from their t-statistics. Nor is their joint distribution significantly different from a(0, 0, 0)-distribution; the relevant $F(6,41)$-statistic is only .648. Therefore, despite showing regression coefficients of the expected sign, the hypothesis that proximity to the BART station increases rents whereas closeness to the tracks decreases them, is rejected.

The rental figures here are "median" rents, i.e., where the primary data indicated a range of rents for a particular building, the median was computed and utilized in the above analysis. Separate analyses were also performed on the sub-samples containing only lower or upper range rentals. These regressions likewise failed to show significant impacts.

Rental data were collected for buildings up to 14,000 feet from the Walnut Creek BART station partially to obtain a larger sample but also to check whether BART's potential effect would extend that far away. Although the BART terms themselves turned out to be statistically insignificant, the constant in the model is positive and highly insignificant. Thus, the rents in the entire study area have risen more than in the Bay Area in general and it is conceivable that this is at least partially due to BART. When BART opened service to Oakland, and especially to San Francisco, the improvement in accessibility for the whole area was substantial. One of the key informants thought that BART had had such an areawide effect, although compared to everything else it would be marginal.

Residential Rents -- Walnut Creek

PERIOD: AFTER 1972...1976 / AFTER 1976...1977

$$R2/R1 = .937 + 575.695(1/DBS) + 83.485(1/DBT) - 270.204(1/DFA)$$

t: 32.094* 1.672 .618 -1.611

N = 9
R^2 = .551
DW = 1.918
SER = .320
V% = 32.14
$F(3,5)$ = 2.048

Domain: $2\,400 \le DBS \le 12\,000$; $1\,650 \le DBT \le 8\,000$

Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	1/DBT	1/DFA
1/DBS	1.000	.317	.906
1/DBT		1.000	.044
1/DFA			1.000

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
R2/R1	..	.996	.356
R1	$	385	76.1
R2	$	381	64.0
DBS	feet	6 697	5 806
DBT	feet	3 697	1 873
DFA	feet	6 000	5 072
YR1	cal. year	74.2	1.3
YR2	cal. year	76.4	.9
Y2Y1	years	2.2	1.1

Remarks

No deliberate data collection effort was made to obtain data for an analysis of what has happened to rents since BART opened for service (an After/After analysis). However, as a by-product of our primary data collection we obtained nine pairs of rentals at varying dates since 1973, and it is of some interest to look at the analysis results here, although the data base is very narrow indeed.

We also note that the value of the constant in the estimated equation, while re-

maining statistically insignificant, has dropped below unit, and the average value of the whole function is also less than one (.996). This may indicate that the initial boost in areawide accessibility, and rents, has since gone and the rents in the area have followed the general pattern in the Bay Area.

It is further notable that the analysis of rental changes does not collaborate the findings of the analyses of the property price changes in the area. In particular, in Walnut Creek the renters appear to be less sensitive to the negative influence of the BART station with its overflowing parking lot and attendent automobile traffic. Suggested reasons for this might be that renters have available parking on the premises which is protected from outside users (whereas street parking in front of single family residences is not similarly protected) and apartment renters may consist to a larger extent of adults who may be less sensitive to surrounding traffic than families with small children.

D. OFFICE RENTS

Downtown San Francisco

The Embarcadero and Montgomery Street stations serve the office core of San Francisco. The BART line is entirely underground in this area.

In recent years, there has been an office building boom, in part attributable to BART, along the portions of Market Street served by these two stations. The domain of the high-rise office building has also expanded south of Market Street, especially in the Embarcadero station area, leaving few land uses in this study area besides office buidings and parking lots.

The financial institutions tend to be concentrated in the vicinity of Montgomery Street, but other major office buildings are found near both stations. New office buildings are currently being built adjacent to both stations (301 Market and 595 Market).

North of Market Street and away from BART most of the major office buildings built since 1960 have been built along California Street or Sansome Street. South of Market Street and away from BART new office buildings for other than institutional or utility clients have recently appeared. This area has traditionally been unattractive to many office users because of its distance from other major office buildings and from convenient intra-city transit. The situation is now changing, however, partially due to the difference in the price of land above and below Market Street.

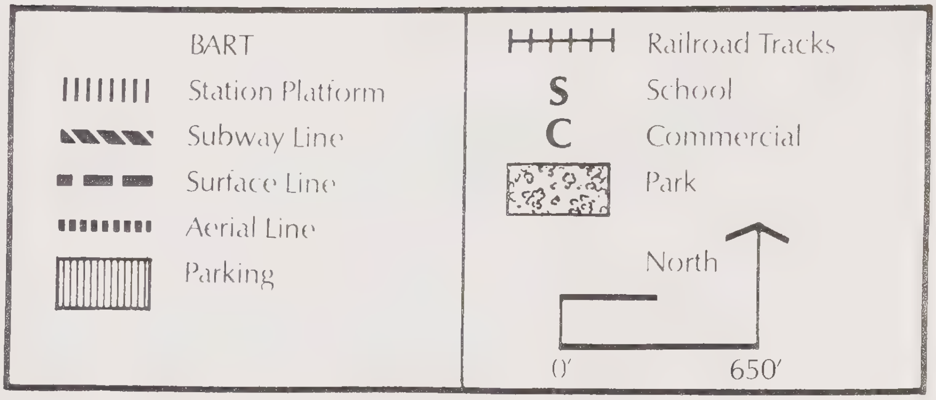
Mission Street and other streets below Market between the Trans-Bay Bus Terminal and the proposed Yerba Buena Center has not yet been penetrated by new office buildings. A mixture of stores, manufacturers, warehousing, old office buildings and parking lots fills in this pocket of land.

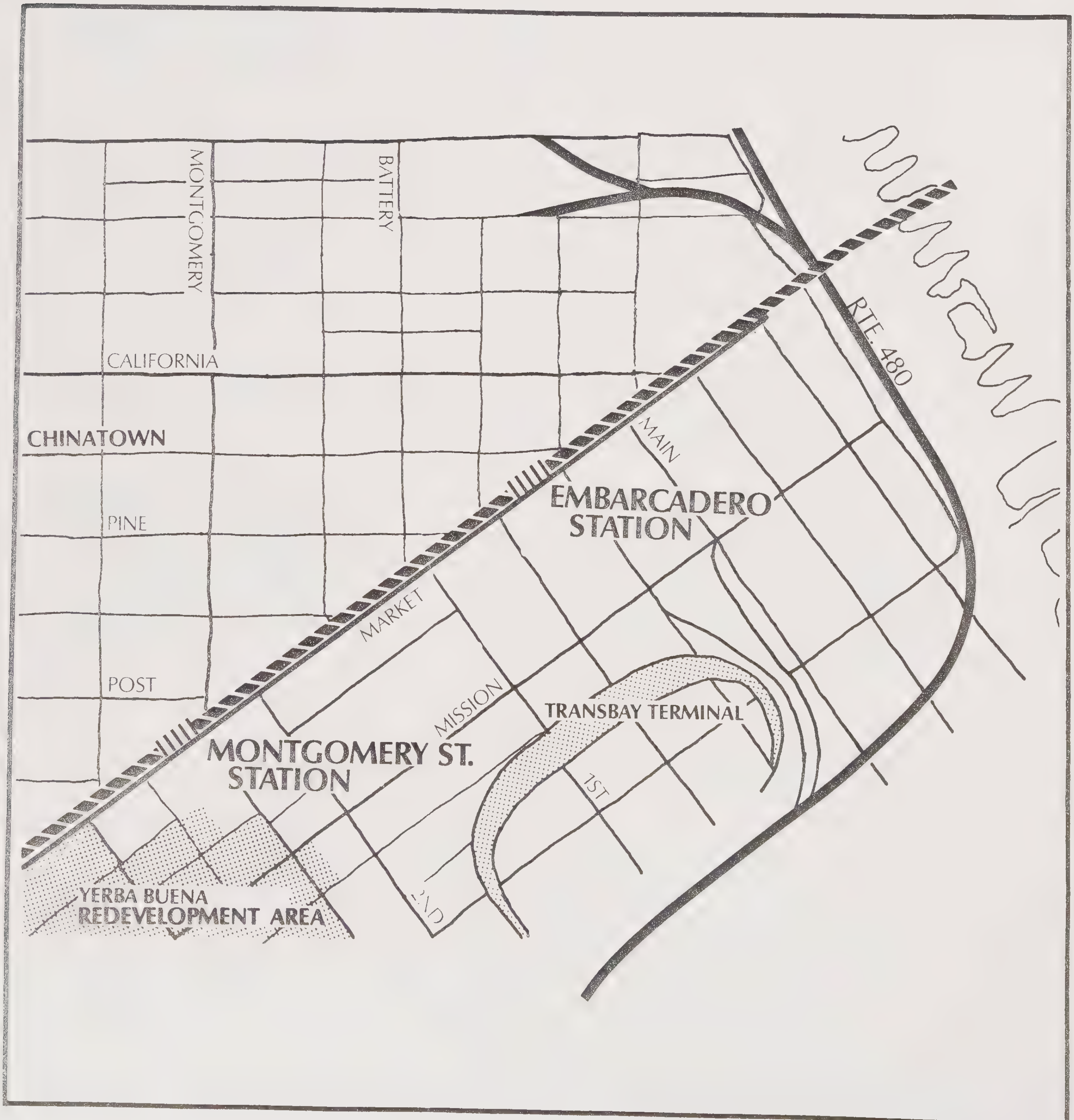
Aside from office buildings, each station has one major hotel nearby. Non-office uses also surround the study area: above Washington Street, north of the Embarcadero station are the Golden Gateway high-rise apartments; to the northwest of downtown is Chinatown; to the west is the major retail section of San Francisco. To the southwest a convention center and other facilities are planned for the vacated Yerba Buena land. Finally, to the south there is a gradual and roughly defined transition from office uses to manufacturing, wholesaling, warehousing and similar land uses.

PERIOD: CONSTRUCTION/AFTER
1972 1978

R2/R1 =	1.174	+ 1.387(1/DBS)	- .0737(MA)	- .353(R1)	
t	14.349*	1.406	-1.953*	-5.092*	
	- .00153(AGE)	+ .108E-3(PAR)			
	-2.175*	1.787*			

SAN FRANCISCO FINANCIAL DISTRICT





Office Rents -- Downtown San Francisco

N = 57
R^2 = .381
DW = 1.786*
SER = .0905
V% = 10.9
F(5,51) = 6.268*

Domain: 20 ≤ DBS ≤ 1 850

Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	MA	R1	AGE	PAR
1/DBS	1.000	.616	.107	-.279	-.367
MA		1.000	-.007	.278	.272
R1			1.000	-.651	.009
AGE				1.000	-.267
PAR					1.000

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
R2/R1	..	.833	.109
R1	$/sq.ft.	.789	.257
R2	$/sq.ft.	.645	.190
DBS	feet	521	382
PAR	no. of parking places	113	225
YRB	cal. year	30.8	26.8
YR1	cal. year	72.0	.3
YR2	cal. year	77.9	.3
Y2Y1	years	5.9	.4

Remarks

A realistic hypothesis that the coefficient of 1/DBS equals some small but positive value, say 2.0, cannot be rejected. (Of course, neither can the simplistic hypothesis that the coefficient equals zero be rejected.) Moreover, a F-test of the joint hypothesis that the coefficient of 1/DBS equals 2.000 and that of the multicollinear dummy variable MA equals a small negative value -.050[14]

14. A small negative value was suggested by John McMahan of John McMahan Associates, Inc., San Francisco.

yields an F(5,51) of 2.036 which is less than the appropriate critical value of 3.18 at the 5 percent risk level. Similarly, a joint test of the hypothesis that the coefficient of 1/DBS is 2.000 and the coefficient of AGE equals -.00265 (the estimated value of the downtown Oakland sample) yields a F-value of 1.879 which is also too small to enable us to reject the hypothesis.

We therefore conclude that one can reject the hypothesis that proximity to BART had no impact on office rents in downtown San Francisco. However, in evaluating the quantitative effect of BART, the multicollinearity between 1/DBS and MA must be observed, i.e., for a small value of DBS a unit value for MA is much more likely than a zero. From a prediction point of view, the possible biases in the estimated coefficients of 1/DBS and MA has no consequence — as long as both variables are considered jointly—because the dependence between proximity to a BART station and a location on Market Street is likely to continue unaltered in downtown San Francisco in the foreseeable future.

During the course of collecting office rental data we talked to many leasing agents and building managers. Thirty of these persons offered comments on BART's possible effect on office rents in San Francisco. These experts, however, were divided in their opinions: eighteen thought that BART had no impact and ten said it had a marginal effect, or that BART was a consideration in the determination of rental rates. Two of the informants said they could not judge BART's effects. In light of these opinions, the analytical finding of a small, and joint, effect of BART on office rents certainly appears reasonable.

12th & 19th Streets, Oakland

The 12th and 19th Street stations serve the Oakland central business district (CBD), an area consisting primarily of office buildings, older commercial buildings, and parking lots. The CBD extends linearly along Broadway from Jack London Square to above Grand Avenue. Because of the linear form of the CBD stores are not always within easy walking distance of each other. Offices are somewhat more clustered.

Much of the recent office development in Oakland has occurred in the "uptown" area of the CBD bounded by 19th Street, Broadway, Grand Avenue and Lake Merritt. The other concentration of office buildings occurs in the vicinity of the 12th Street BART station. On the west side of the station is the new City Center Project. The Project's plans call for a hotel, convention center and stores, but so far only two office buildings have been completed. East and north of the station are a number of older office buildings, representing the original office core of the City. Retail stores extend northward chiefly along Broadway and Telegraph Avenue.

The data available for Oakland provide us with the range of rents in a particular

building. Since it is conceivable that the space-renting at the upper end of the range has faced a different market than that renting at the lower end of the spectrum, separate analyses were performed for the upper and the lower ranges, as well as for the implied median rents. The symbols U, L, and M for rents below reflect the division. Thus, e.g., U2/U1 stands for the relative change in upper range rents.

The variable O_{-1} designates the occupancy rate, in percent, in the building lagged by one year, that is, in the year preceding that of the change in rent (i.e., in the case below, O_{-1} refers to 1977).

The variable TYPE is defined as 1 when the building in question has been designated as a building of the highest (best) class in Oakland; otherwise it is equal to zero.

PERIOD: 1973/1978

Upper Range:

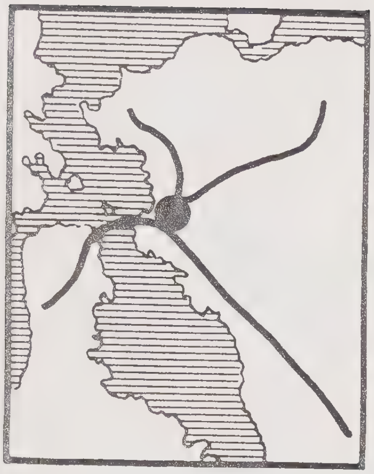
$$\begin{array}{llllll} U2/U1 = & 1.372 & + 22.503(1/DBS) & - .00356(O_{-1}) & - .00275(AGE) & - .200(TYPE) \\ t & 11.393^* & 2.339^* & -3.704^* & -2.619^* & -2.318^* \end{array}$$

N = 26
R^2 = .553
DW = 2.471*
SER = .113
V% = 13.1
F(4,21) = 6.491*

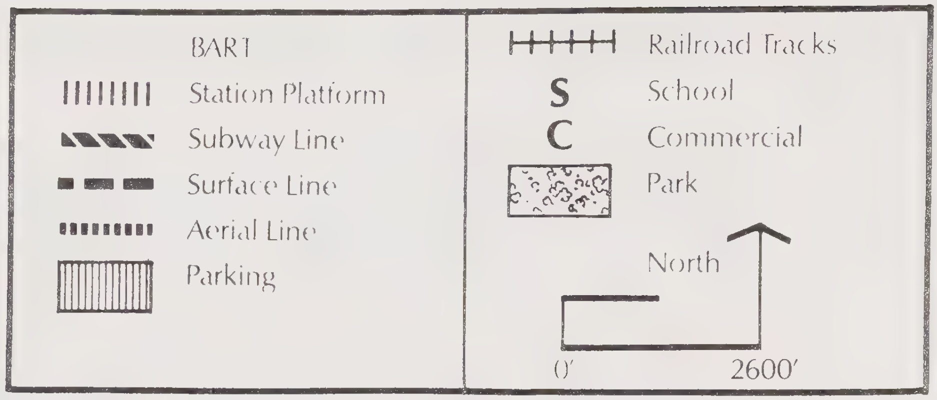
Domain: $75 \leq DBS \leq 4\ 000$

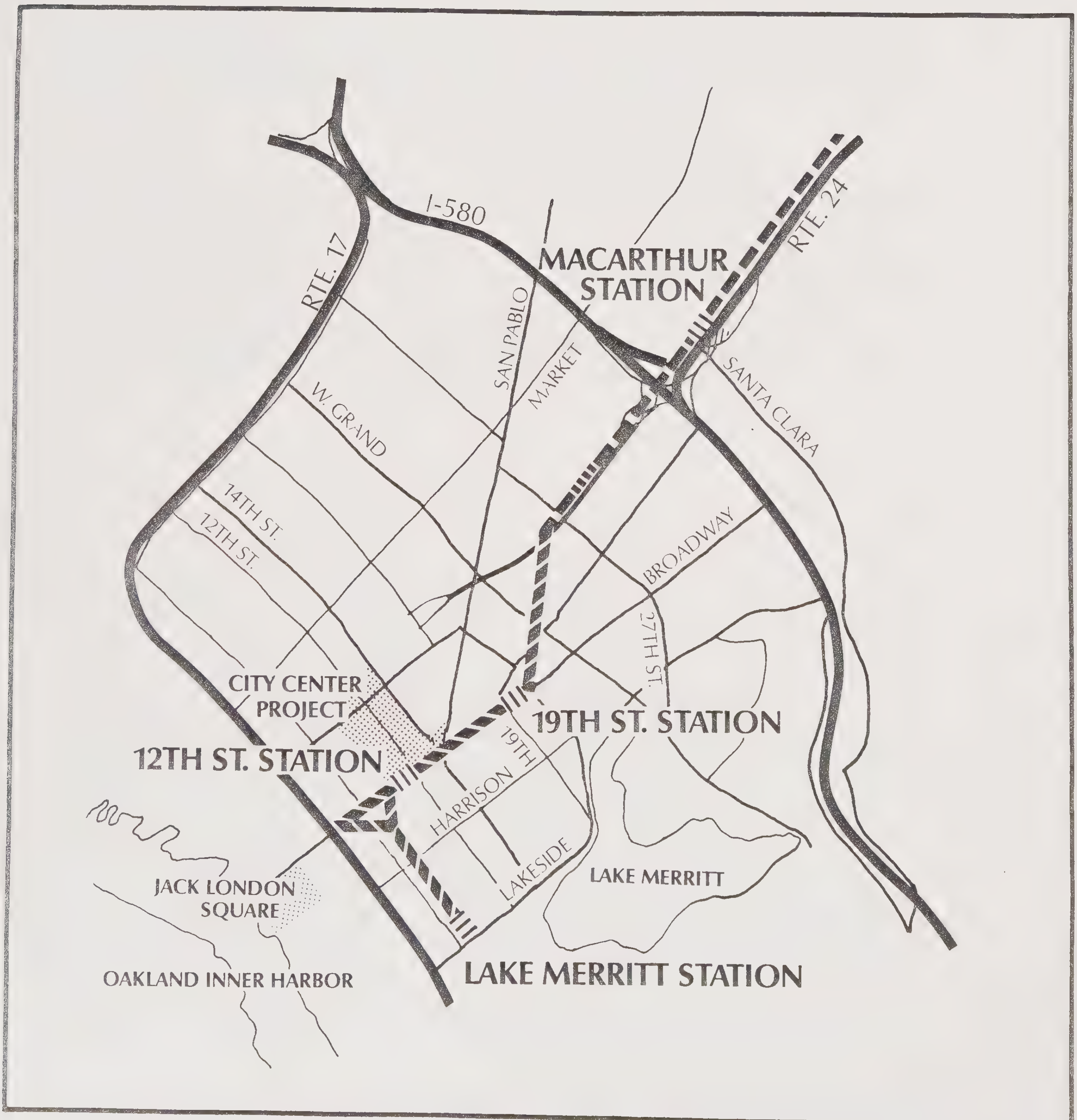
Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	O_{-1}	AGE	TYPE
1/DBS	1.000	.116	.254	.095
O_{-1}		1.000	-.086	-.125
AGE			1.000	.194
TYPE				1.000



DOWNTOWN OAKLAND





Office Rents -- 12th & 19th Streets, Oakland

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
U2/U1	..	.861	.152
U1	$/sq.ft.	.609	.259
U2	$/sq.ft.	.570	.139
DBS	feet	.930	725
O_{-1}	%	83.3	18.7
YRB	cal. year	48.2	22.4
AGE	78 - YRB		
TYPE	1 if class 1 0 otherwise	.923	.266

Lower Range:

$$\begin{array}{llllll} L2/L1 = & 1.367 & - 12.678(1/DBS) & - .00306(O_{-1}) & - .00253(AGE) \\ t & 12.950^* & -1.378 & -3.722^* & -2.818^* \end{array}$$

$$\begin{array}{ll} - .196(TYPE) & + .106(REN) \\ -2.529^* & 1.908^* \end{array}$$

N = 26
R^2 = .6675
DW = 1.893*
SER = .096
V% = 11.2
F(5,20) = 8.030*

Domain: $75 \leq DBS \leq 4\ 000$

The variable REN is a dummy variable defined as 1 in case the building has been renovated, zero otherwise.

Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	O_{-1}	AGE	TYPE	REN
1/DBS	1.000	.103	.219	.221	.452
O_{-1}		1.000	-.086	-.119	.006
AGE			1.000	.190	.016
TYPE				1.000	-.311
REN					1.000

Office Rents -- 12th & 19th Streets, Oakland

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
L2/L1	..	.859	.146
L1	$/sq. ft.	.555	.231
L2	$/sq. ft.	.523	.113

All other variables are as for the *Upper Range* sample.

Median Range:

$$M2/M1 = \underset{12.868^*}{1.354} + \underset{.260}{2.383}(1/DBS) - \underset{-4.043^*}{.00331}(O_{-1}) - \underset{-2.962^*}{.00256}(AGE) - \underset{-2.373^*}{.184}(TYPE) + \underset{1.566}{.0870}(REN)$$

t (shown beneath each coefficient)

N = 26
R^2 = .640
DW = 2.257*
SER = .09605
V% = 11.2
$F(5,20)$ = 7.113*

Domain: $75 \leq DBS \leq 4\,000$

Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	O_{-1}	AGE	TYPE	REN
1/DBS	1.000	.103	.219	.221	.452
O_{-1}		1.000	-.086	-.119	.001
AGE			1.000	.190	.016
TYPE				1.000	-.311
REN					1.000

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
M2/M1	..	.860	.140
M1	$/sq. ft.	.582	..
M2	$/sq. ft.	.547	..

All other variables are as for the *Upper Range*.

Remarks

Statistically, the above estimated equations are satisfactory. They do not exhibit signs of multicollinearity, positive autocorrelation, nor heteroscedasticity.

Thus, the hypothesis that proximity to downtown Oakland BART station increases the change in office rents cannot be rejected. However, this seems to hold true only for the upper range of the rents. The lower range, and the consequent median rents remain unaffected by the distance to BART. Hence, and since typically the newer and the larger office buildings depict a rental range (rather than a flat rent for any space in the building), one might conclude that it is the prestige offices which value proximity to a BART station.

The negative sign of the coefficient of the Occupancy Rate-variable might appear surprising at first sight. A possible explanation, however, is that a fully or nearly fully occupied building may be locked into fixed-rate leases for several years, whereas the buildings with vacancies have greater opportunities to adjust their rents (upwards) as new tenants move in.

This same phenomenon might also account for the fact that separate analyses which stretched over only two-year periods (1974 versus 1973 for immediate BART effects, and 1978 versus 1977 for most recent effects) failed to reveal significant results with respect to any variable, including BART.

Finally, it must also be stressed here that, although the sample extended over the entire Oakland downtown area, and distances to the nearest BART station involved all three downtown stations, most of the buildings which are near a BART station in the sample, are also near the new City Center. Part of the coefficient of 1/DBS may therefore reflect the City Center effect and not solely and directly BART. But then again it might be argued that the City Center itself is a BART effect.[15] Nevertheless, it is statistically hazardous to make a direct comparison between the coefficients of 1/DBS for the San Francisco and Oakland samples. However, we note that the magnitude of the coefficient estimate of 1/DBS for the medium range sample is remarkably close to that of the San Francisco sample.

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15. John Blayney Associates/David M. Dornbusch & Company, Inc., Study of the Office Construction Industry (Berkeley: BART Impact Program Land Use and Urban Development Project Working Paper, 1978).

Walnut Creek

The Walnut Creek BART station is located one mile north of Walnut Creek's downtown shopping area and adjoins Interstate 680 and Ygnacio Valley Road, a major east-west corridor. Although the area is primarily residential, there is sufficient office and retail development to designate Walnut Creek as a regional sub-center for the Central Contra Costa County suburbs. For a map of the area, see page 84.

Land west and north of the BART station is almost exclusively in residential use, except for properties fronting on North Main Street. There are apartment buildings to the north, especially above Geary Road, but single family dwellings predominate. Immediately south of the BART station area and west of California Boulevard lies another residential area, with apartment buildings predominating in the blocks closest to the BART station.

Core area development plans have focused on keeping downtown Walnut Creek competitive with suburban shopping malls by providing increased parking especially in the Broadway Plaza area where the largest amount of retail activity is centered. Office development has occurred in scattered nodes around the periphery of the downtown shopping area. East of the BART station a great deal of development in recent years has centered around Ygnacio Valley Road. The new development extends from the BART station northeast to beyond Oak Grove Road. A major office center has been constructed in the Shadelands property, near the junction of Ygnacio Valley and Oak Grove Roads. Office and retail construction has also occurred near the BART station. Walnut Creek Plaza, the largest office building in central Contra Costa County, is directly across from the BART station, and Cost Plus has a new store next door; a new municipal court building is located at the corner of Ygnacio Valley Road and Main Street.

PERIOD: AFTER 1971...1974 / AFTER 1978

R2/R1 =	.734	+ 33.038(1/DBS)	+ .502E-3(PAR)	+ .0223(AGE)
t	8.049*	.809	2.851*	2.265*

N = 37
R^2 = .238
DW = 2.010*
SER = .114
V% = 11.5
F(3,33) = 3.441*

Domain: $450 \leq DBS \leq 11\,100$

Office Rents -- Walnut Creek

Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	PAR	AGE
1/DBS	1.000	.026	.114
PAR		1.000	-.458
AGE			1.000

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
R2/R1	..	.986	.123
R1	$	.694	.112
R2	$	.681	.116
DBS	feet	3 661	2 366
PAR	no. of parking spaces	130.4	119.4
AGE	years	7.8	2.1
YR1	cal. year	72.9	1.0
YR2	cal. year	78.0	0.
Y2Y1	years	5.1	1.0

PERIOD: AFTER 1974 / AFTER 1978

$$R2/R1 = \underset{7.245*}{.800} + \underset{1.995*}{99.225}(1/DBS) + \underset{3.206*}{.635E\text{-}3}(PAR) + \underset{2.589*}{.0266}(AGE)$$

$$- \underset{-1.728}{.0217}(STO) - \underset{-1.566}{.0770}(TS)$$

(t values shown beneath coefficients, row labelled t)

N = 17
R^2 = .658
DW = 1.911
SER = .0759
V% = 7.5
F(5,11) = 4.231*

Domain: $450 \leq DBS \leq 11\ 100$

Office Rents -- Walnut Creek

Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	PAR	AGE	STO	TS
1/DBS	1.000	.062	.009	.611	.296
PAR		1.000	-.529	.010	-.270
AGE			1.000	.177	-.164
STO				1.000	-.565
TS					1.000

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
R2/R1	..	1.016	.104
R1	$	.679	.093
R2	$	.688	.105
DBS	feet	3 747	2 517
PAR	no. of parking spaces	135	112
AGE	years	7.6	2.2
STO	no. of stories	3.6	2.3
YR1	cal. year	74.0	0.
YR2	cal. year	78.0	0.
Y2Y1	years	4.0	0.

The variable TS is a dummy variable defined as 1 when the tenants in the building are predominantly small firms, and zero otherwise (since there were no buildings with large office tenants included in the sample, TS = 0 implies predominantly medium-sized office tenants).

Remarks

Although the sample sizes are relatively small, and there is some multicollinearity in the latter sample between proximity to BART and the number of stories in the building, the following conclusions nevertheless seem appropriate. There is no discernible BART impact on office rents in Walnut Creek from the time when BART construction was almost completed and service to Oakland began. Possibly anticipations had already raised the rent levels so that the increases since then mainly reflect general construction cost increases.

However, since service to downtown San Francisco began in 1974, proximity to the Walnut Creek BART station has had a clear, increasing effect on office rents. If we represent the multicollinearity between proximity to the station

and the number of stories in the building simply by their linear correlation, we have the following equation:

$$STO = 3.975 - .000182(DBS); \quad r = -.197$$

When we now substitute this relationship into the estimated equation above, and assign to the other explanatory variables -- except 1/DBS — their respective sample means, the equation reduces to

$$R2/R1 = .925 + 99.225(1/DBS).$$

It follows that a building at 450 feet from the station might rent for approximately 20 percent more than another building 4,000 feet away, assuming that the buildings are otherwise similar office buildings of average age, height and tenant mix.

Again, ten of the informants we spoke to regarding office rents in Walnut Creek were divided equally between those who said that BART has had absolutely no effect and those who thought that proximity to the BART station has had a positive effect on the rental market. Some indicated that the BART effect, if present, would diminish rather rapidly, certainly vanishing at a distance of 2,000 feet from the station.

E. COMMERCIAL PROPERTY PRICES

Mission District, San Francisco

In the Mission District of San Francisco BART operates underground. The more northerly of the two stations serving the Mission District is at 16th Street and Mission. This station area presently contains a mixture of industrial, commercial and residential land uses. Activities outside of the station area are causing some instability there. According to a City Planning Department official, residents fear office construction will spill over from the downtown, or that the area will become a new skid row.[16] On one hand, there has been a recent upswing in office construction in the vicinity of the Civic Center, just north of the 16th Street station area. But at the same time, demolition by the Yerba Buena Center project of the old "Tenderloin" area has caused an influx of street-people into the 16th Street station area and created some concern. There have also been a number of fires in the area, many suspected to be arson. As a consequence of all this, the area is very labile but the direction of a possible change in the character of the area is uncertain. This is reflected in the uneasiness of the real estate market in the area.

Residential units consist primarily of older stock, low-density single-family and duplex row houses. Apartments and flats tend to be small, in the three- to nine-unit range. The greatest concentrations of residential units occur southwest of the BART station and to the west, towards Dolores Street.

Industrial manufacturing and warehousing uses intrude upon the northern and western sections of the District, but the centers of such activities lie outside the Mission District. Most of these buildings, too, are old and may be approaching obsolescence.

Commercial activity is found on most of the major thoroughfares, with Mission Street being the busiest of these. There are currently only a few scattered office buildings in the area.

The 24th Street and Mission station is the more southerly of the two BART subway stations serving the Mission District. This station area consists primarily of older residential stock and strip commercial development running along several of the major streets.

Residential units in the area consist mainly of low-density single family and duplex row houses and three- to nine-unit flats and apartments. Some larger apartment buidings also exist, but high-rise apartments are precluded by height limitations that cover most of the district.

Many of the buildings used for commercial activity in this area are older mixed-use buildings with flats or other residential units atop the ground-floor commercial use. Newer commercial development includes an increasing number of fast-food businesses. Most commercial activity is oriented towards the local community.

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16. Robin Jones, San Francisco Planning Department, 8 February 1978.

Commercial Property Prices — Mission District

There are very few offices or industrial buildings in the area. One-third of a mile south of the 24th Street station lies St. Luke's Hospital, accompanied by medical offices and related uses. The San Francisco General Hospital complex lies three-quarters of a mile to the east of the 24th Street station.

PERIOD: BEFORE, CONSTRUCTION/AFTER
1961...1971 1972...1977

$$S2/S1 = .495 + 41.134(1/DBS) - 3.265(1/DM) + .00502(AGE)$$

t: 2.130* .399 -.576 1.867*

N = 17
R^2 = .211
DW = 1.496
SER = .222
V% = 26.0
F(3,13) = 1.1615

Domain: $225 \leq DBS \leq 2\ 400$

Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	1/DM	AGE
1/DBS	1.000	.783	-.225
1/DM		1.000	.314
AGE			1.000

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
S2/S1	..	.853	.218
S1	$	175 666	213 159
S2	$	155 080	204 545
DBS	feet	932	486
DM	feet	808	515
AGE	years	64.2	21.1
YR1	cal. year	64.8	3.35
YR2	cal. year	74.6	1.8
Y2Y1	years	9.8	3.7

Commercial Property Prices -- Mission District

PERIOD: BEFORE / CONSTRUCTION
1961...1966 1967...1971

$$S2/S1 = -.077 + 171.029(1/DBS) - 12.358(1/DM) + .00479(AGE) + .156(CL)$$

t	.199	2.717*	- 2.081*	1.346	2.935*

N = 11
R^2 = .704
DW = 2.284*
SER = .224
V% = 22.3
F(3,7) = 3.571*

Domain: $225 \leq DBS \leq 2\,400$

Estimated Correlation Matrix of Estimated Coefficients:

	1/DBS	1/DM	AGE	CL
1/DBS	1.000	.814	-.493	-.365
1/DM		1.000	.609	.478
AGE			1.000	-.651
CL				1.000

Sample Statistics:

Variable	Unit	Average Value	Standard Deviation
S2/S1	..	1.005	.305
S1	$	130 006	106 103
S2	$	119 781	92 582
DBS	feet	1 018	641
DM	feet	728	663
AGE	years	44.6	28.0
CL*		4.6	1.7
YR1	cal. year	62.4	2.1
YR2	cal. year	68.6	1.2
Y2Y1	years	6.3	2.5

*CL denotes building class, as designated by the San Francisco Assessor.

Commercial Property Prices -- Mission District

Remarks

The sample here consists of information on the repeat sale of various types of mainly small, commercial property. Typical examples are gas stations and retail stores. Because such property has a relatively low turnover rate, the sample is of necessity very limited in size. The samples are, moreover, intertwined by multicollinearity, making formal hypothesis testing hazardous.

In the first sample, the Before Construction/After analysis, the BART coefficient is very small compared to its standard error and does not differ significantly from zero. However, since 1/DBS and 1/DM are clearly multicollinear, it is proper to consider their joint distribution. Thus, an F-test of the hypothesis that the coefficients of these two variables are both equal to zero yields an $F(7,7) = .339$, clearly much too low to enable us to reject the joint hypothesis. One must conclude that the insignificance of the BART variable is probably not due to multicollinearity, but is genuine.

The analysis of the Before/Construction sample displays a significant BART effect, presumably due to positive anticipations regarding BART's ability to bring customers to the station area. Although multicollinearity and the small sample size make the coefficient estimate of 171.029 appear suspiciously high, the hypothesis that proximity to the BART station had no impact can, given key informant opinions and the similar results for the residential analyses, be rejected. Thus, once more, we conclude that BART had some positive effect on property prices at the time when anticipations were still high, but this impact has since then disappeared.

To get a numerical estimate of the effect that anticipated BART service, the existing multicollinearity can be accounted for by deriving values for the explanatory variables which are implied by the simple linear correlations among the variables, given various values for DBS. Thus,

$$\mathrm{DM} = -133.424 + .846(\mathrm{DBS});\ r = .818$$

$$\mathrm{CL} = 4.518 - .000163(\mathrm{DM});\ r = -.0647$$

$$\mathrm{AGE} = 84.929 - 8.690(\mathrm{CL});\ r = -.517$$

DBS	S1/S2
100	2.811
200	1.356
500	1.141
1 000	.987

The corresponding, expected values of the function, at selected values for DBS, are presented below:

Commercial Property Prices -- Mission District

DBS	S1/S2
100	2.811
200	1.356
500	1.141
1 000	.987

Hence, the prices for commercial property near a BART station in the Mission are estimated to have nearly tripled in anticipation of BART service. This positive impact, however, diminishes rapidly and vanishes totally by some 1,000 feet from a station.

APPENDIX B. KEY INFORMANTS INTERVIEWED

	Informant	Geographic Area Discussed
(*)	John Sullivan, President, Pacific Properties Development Company	Walnut Creek office and residential rents
(*)	Carol Price, Chief of Property Management, Pacific Properties Development Co.	Walnut Creek residential rents
	Jay P. de Leau, Executive Vice President, Walnut Creek Chamber of Commerce	Walnut Creek office rents and residential sales
(*)	John Grobe, President, John Grobe & Co.	Walnut Creek, office rents and residential sales
	Les Foley, Walnut Creek Community Development Department	Walnut Creek residential sales
(*)	Dick Doyle, Real Estate Agent, Valley Realty, Hayward	Hayward residential sales
(*)	Marvin Casalina, Private Appraiser, Pleasanton	Hayward residential sales
(*)	Don Sanchez, Real Estate Agent, Century 21-Adobe Realty, Hayward	Hayward residential sales
(x)	President, Hayward area real estate company	Hayward residential sales
	Leandro P. Soto, Executive Director, OBECA/Arriba Juntos	Mission residential rents, residential and commercial sales
	Ben Ramos, President, Mission Economic Development Association	Mission residential rents, residential and commercial sales
	Mackey C. Salazar, Attorney, Mission District	Mission commercial sales
	Thomas Doherty, owner, Thomas H. Doherty, Inc.	16th and Mission commercial sales

NOTE: (*) indicates that informant was interviewed specifically for this study; (x) indicates that informant wishes to remain anonymous.

Informant	Geographic Area Discussed
Raymond Haymon, Grubb & Ellis Commercial Brokerage Firm	Oakland office rents
Michael Kaplan, Architect, Oakland City Architectural Department	Oakland office rents
Dene Ogden, Private Appraiser	Oakland office rents
(*) William Cole, Assistant Vice-President, Coldwell Banker	San Francisco office rents
H. W. Ehlers, President, Milton Meyers	San Francisco office rents
(*) Carol Gilbert, Leasing Agent, Grubb & Ellis Commercial Brockerage	San Francisco office rents
(*) Tim Costello, Leasing Agent, Cushman & Wakefield	San Francisco office rents
(*) John Johnston, Leasing Agent, Cushman & Wakefield	San Francisco office rents
(*x) Representative, Ritchie & Ritchie Management Company	San Francisco office rents
(*) Steve Shain, Leasing Agent, Arthur Rubloff & Company	San Francisco office rents
(*) Jim MacDonald, Property Management Section, Coldwell Banker	San Francisco office rents
(*x) Representative, Fox Plaza Office Building	San Francisco office rents
(*) John Colver, First Vice President, Tishman Realty & Construction	San Francisco office rents
(*) Mr. Bernheim, Building Manager, Hobart Building, 582 Market	San Francisco office rents
(*) Assistant Manager, 681 Market and 116 New Montgomery	San Francisco office rents
(*) Assistant Manager, 703 Market	San Francisco office rents
(*) David Hardin, Vice President, Continental Insurance Company	San Francisco office rents

NOTE: (*) indicates that informant was interviewed specifically for this study;
(x) indicates that informant wishes to remain anonymous.

	Informant	Geographic Area Discussed
(*)	Joe Desautels, Manager of Commercial Development, Crocker Plaza	San Francisco office rents
(*)	Mr. Carney, Building Manager, Call Building, 74 New Montgomery, S.F.	San Francisco office rents
(*x)	Representatives, Norris, Beggs & Simpson	San Francisco office rents
	Francis Sitek, Standard Oil Corporation	San Francisco office rents
(x)	Representative, Office Developer	San Francisco office rents
(*)	Bob Walker, Leasing Agent, Tischer Realty	San Francisco office rents
(*)	Edward Keil, President, Keil Estate Company	San Francisco office rents
(*)	Representative, Yosemite Life Insurance	San Francisco office rents
(*)	Representative, Geary-Market Company	San Francisco office rents
(*)	Ms. Berry, Leasing Agent, Milton Meyers	San Francisco office rents
(*)	Mr. Wasson, Harrigan Weidenmullen	San Francisco office rents
(*)	Milton Surkin, Blatteis Realty	San Francisco office rents
(*)	Ted Weiner, Building Manager, 130 Bush	San Francisco office rents
(*)	Julie Glassberg, Manager, 625 Market	San Francisco office rents
	Gerson Bakar, President, Gerson Bakar	San Francisco and Walnut Creek office rents
	Orra Hyde, Vice President, Coldwell Banker	San Francisco and Walnut Creek office rents
	Hal Thomas, Systec Corporation	Walnut Creek office rents
(*)	Representative, Newman Realtors	Walnut Creek office rents
(*)	Mr. Cook, G.E. Cablevision	Walnut Creek office rents
(*)	James Champion, Owner, 1657 N. California	Walnut Creek office rents
(*)	John Montgomery, Leasing Agent, Parker-Ritchie Management Corporation	Walnut Creek office rents

NOTE: (*) indicates that informant was interviewed specifically for this study;
(x) indicates that informant wishes to remain anonymous.

Informant	Geographic Area Discussed
(*) S. D. Burgess, Director, Heald Business College, Walnut Creek	Walnut Creek office rents
(*) William T. Nork, Leasing Agent, Coldwell Banker	Walnut Creek office rents
Norm Meltzer, Interland	Walnut Creek office rents
(*) Webb Johnson, Manager, Quail Court Office Park	Walnut Creek office rents
(*) Mrs. Zenor, Co-owner, 2020 N. Broadway and 630 Ygnacio Road, Walnut Creek	Walnut Creek office rents

NOTE: (*) indicates that informant was interviewed specifically for this study;
(x) indicates that informant wishes to remain anonymous.

APPENDIX C. DATA COLLECTION

BART's effect on residential and commercial sales prices and rental rates was studied in ten station areas: Walnut Creek and Pleasant Hill, El Cerrito Plaza, South Hayward, the 12th and 19th Street and Lake Merritt stations in Oakland, and the Embarcadero, Montgomery, 16th and Mission, 24th and Mission, and Glen Park stations in San Francisco. For each building included in the study sales or rental data were collected in at least two of the three time periods of interest: pre-BART construction, during BART construction, and BART service. All sales and rental figures were standardized for inflation by use of real estate cost indices calculated by the Real Estate Research Council of Northern California.[1]

Each building's distance from the nearest BART station was the key independent variable in the analysis. Data on other characteristics of the building and its location were also collected so that other influences on sales or rental rates could be recognized.

RESIDENTIAL SALES

Data on residential sales prices were collected for areas in the vicinity of six BART stations: Walnut Creek, El Cerrito Plaza, South Hayward, Glen Park and the 16th and Mission and the 24th and Mission Street stations. The cooperation of Messrs. Tinney and Wanaka, the Assessors of San Francisco and Contra Costa Counties, respectively, greatly facilitated the data collection process in those two counties.

For Walnut Creek and El Cerrito we attempted to compile a sample of residential sale prices based on sales information in the Contra Costa County Assessor's Office.[2] Unfortunately, we found that most of the records before 1969 were incomplete. Therefore, a listing of property-related transactions for each sampled parcel was used to trace the dates of earlier possible sales.[3] Examination

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1. Real Estate Research Council of Northern California, Northern California Real Estate Report, San Francisco (monthly). A housing price index for each community was used to deflate residential sales figures. A residential rental index was used to deflate residential rental figures. Office construction and commercial building construction indices were used to deflate the office rent and commercial sales figures. See Appendix A for a full description of the deflating of prices and rents.

2. See Andrejs Skaburskis, Survey of Data Sources for the Land Use and Urban Development Project (Berkeley: BART Impact Program, 1975, pp. 9-12).

3. A list of the last three property transactions for each parcel is given as part of the Assessor's Office microfilmed Assessment Rolls each year in recent years.

of deed records at the County Recorder's Office was necessary to obtain price figures for sales before 1969.[4]

In both Walnut Creek and El Cerrito the study area covered approximately sixty blocks around the BART stations. The farthest point in the Walnut Creek sample was 4,500 feet from the BART station and the farthest point in the El Cerrito sample was 3,600 feet from BART.

In Alameda County, we did not have access to the assessor's property sales data, so for the South Hayward area the Multiple Listing Service Cumulative Street Index File of the Southern Alameda County Board of Realtors was used to obtain the information. These records extend from the present to January, 1969. Some additional sales records for the South Hayward area for 1964 to 1966 were obtained from the records of Mr. Dene Ogden, a private appraiser.

Properties analyzed in the South Hayward area were those that had been sold at least once during BART's construction period (1967 to 1971) and at least once since then. In all, ninety-three properties were selected.

The area studied includes most of Hayward south of Harder Road and east of Hesperian Boulevard, an area of about nine square miles. This is substantially larger than other stations' study areas, but ensured obtaining a sufficient number of data points and provided an opportunity to assess whether BART influenced housing prices of homes quite distant from the BART station.

For the Mission District and for Glen Park, we obtained sales data with the help of the San Francisco Assessor's office. In Glen Park we compiled information on over 330 properties which had sold in two of the time periods of interest. At the 16th and Mission and the 24th and Mission station areas, we compiled comparable sales data on 134 and 343 properties, respectively. The properties were located within 2,700 feet of the Glen Park station, within 2,800 feet of the 24th and Mission Station, or within 1,800 feet of the 16th and Mission Station.

In all six station areas the sampled properties were mapped and the distance to the local BART station and the other locations which might influence property prices (such as freeways, schools, parks, etc.) were calculated. Additional data on the size of the lot and corner location were also collected. Where BART is above ground, the distance to the BART tracks was calculated. In addition, distance to nearby freeways, shopping centers, and commercial boulevards was found.

RESIDENTIAL RENTS

Residential rental rates were studied in Walnut Creek and in the Mission District. For the Mission District, the primary source of data was the Realtors Multiple Sales Service Comparable Book of the San Francisco Board of Realtors. According to Jeffrey DeLand of the Board of Realtors, approximately one-third

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4. Prices were imputed from tax stamps attached to each deed at a rate of $1.10 per $1,000.

of all property sales transactions in San Francisco are listed with the Board and are recorded in the Comparable Book volumes along with listings for unsold properties. The records extend from present day listings back to March, 1968. Apartment buildings and other residential properties whose prime attraction is their ability to generate rental income are listed separately and the rental rates are often indicated. Sixty-nine cases were found where a property was listed once before BART construction and once more in later years.

In Walnut Creek, the Contra Costa County Board of Realtors' Multiple Listing Service Cumulative Street Index Files provided records of properties available to sell or rent. The Street Index Files run from January, 1969 to the present, and some data from earlier years were also available from the Board. Recent information on residential rents in selected areas was also available from the Walnut Creek Community Development Department. Again, sixty-nine instances were found where rental data were available for an address both before and after BART construction in Walnut Creek ended.

In both the Mission District and Walnut Creek, each sample point was located on parcel maps and the distance to the nearest BART station measured. The size of the parcel and the distance from each sample point to the BART tracks, the nearest freeway and freeway entrance, elementary school, shopping center and park were also measured as possible influences on changes in residential rental rates.

OFFICE RENTS

Office rental data were collected for individual buildings in downtown Oakland (the 12th and 19th Street station areas), the San Francisco Financial District (the Embarcadero and Montgomery Street station areas), and Walnut Creek. Building owners, managers, leasing agents, and other informed parties were contacted for information. We utilized written records of rental rates whenever possible, but often had to rely upon informants' recollection of rental rates. Since rents often vary significantly within a given office building, we tried to obtain figures for the average rental rate in the building and/or the range of rents in the building. The rental figures typically represent fully-serviced office space on a rent per square foot basis. While the "average" rental rate may not be strictly comparable among buildings, the problem is minimized by two factors: (a) we use the rate of change in rental rates in our analysis, and (b) for each building (sample point) the same informant provided both the before-BART office rental rates and the current rates, thus maintaining maximum comparability between the two rents within any given building.

For rents from before BART operations, we sought rental figures from 1972 or earlier for Walnut Creek and San Francisco and from 1973 for Oakland. In San Francisco we also utilized rental information available for 1967 and 1968. Because in Walnut Creek many office buildings were not yet built in 1972, rents were sought for the date a new building first opened in addition to current rental rates.

Information on factors other than BART proximity that could influence office rental rates was compiled, including: the building's age, height, and size, the availability of parking, accessibility to freeways, tenant size and the quality

of the building (in terms of the "class" of construction).[5]

Because key informants felt that rents charged in buildings owned by public institutions may not represent market conditions, such buildings were excluded from the study. Buildings that are completely or primarily owner-occupied may not have rents reflecting true market rental rates and were also dropped. Finally, offices in medical centers or connected to hospitals were excluded, as were office buildings that had been vacant for long periods of time.

The data sources varied from city to city. In Oakland, we relied heavily on the work of Robert P. Marshall of Cushman and Wakefield, Inc. Mr. Marshall has made six comprehensive surveys of office rental rates in the Oakland CBD between September, 1973 and January, 1978. Twenty-four to fifty office buildings in downtown Oakland were included in each survey. Almost all of the buildings have been surveyed more than once: thirty downtown Oakland office buildings are included in four or more of the six rental surveys. The year each office building was built and the total rentable square footage is also included. A description of tenant sizes was obtained from Mr. Marshall or from building owners or managers.

The class-of-construction designation and the number of stories in each office building were obtained through the permit files and Sanborn maps in the Oakland Building Department. Parking availability was determined with the assistance of the "City of Oakland Parking Management Plan, Off-Street Parking Lot Inventory," and an "Off Street Parking Inventory, Oakland Central District" map, both available at the Engineering and Parking Division, Oakland Public Works Department.

In San Francisco, the large number of office buildings in the Financial District necessitated that a sample of buildings be chosen for study. The study area boundaries were defined as equivalent to those used in the BART II Market Street Study report.[6] Since the object of the study is to compare rents from before BART with those since BART began operations, buildings built later than 1972 were excluded. All other office buildings in the study area and appearing on the San Francisco Planning Department's list of "Tall Buildings In San Francisco Downtown Study Area"[7] were included in the sample. In addition, one-third

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5. Building codes in all three cities require identification of all buildings under a series of classes that rate the fire resistance of the buildings, based in large part on the materials used in the construction of the buildings. Fireproof buildings made of concrete, steel and other noncombustible materials fall under classes I and II. Non-fireproof buildings and industrial buildings fall under classes III, IV and V. Most offices in Oakland and San Francisco are class I or II. Many offices in Walnut Creek are wood framed and come under classes III and V.

6. Douglass B. Lee, Jr., BART-II, Part III, Market Street Study, Vol. IV (Berkeley: BART Impact Program, 1973.) The study area is roughly bounded by Washington Street on the north, Chinatown on the west, the San Francisco Bay on the east, and Howard Street on the south.

7. San Francisco Department of City Planning, "Tall Buildings in Downtown Study Area," January, 1971.

of the office buildings recorded in the BART II Market Street Study but not on the list of tall buildings were included, as were all office buildings on Market Street that were within the study area and built by 1972. This selection process yielded a list of 116 buildings for which rental data was sought. The final sample used in the regression analysis was further reduced by excluding those buildings for which we were unable to obtain rents from the same source for each of the years of interest.

No single source of comprehensive office rental information for San Francisco was found. Information on rents was obtained through interviews with leasing agents for office buildings, building owners, managers or agents, from information gathered in the BART II Market Street Study report, and by utilizing rental information made available by the San Francisco Assessor's Office.[8]

The class-of-construction of each building was obtained from the Assessor's Office. Information on the age of the office buildings, the number of stories and the gross floor area of the buildings was available from the Assessor's Office, the Planning Department's list of tall buildings and from the Data Documentation for the Land Use and Investment Study volume of the BART II Study.[9] Tenant size was determined by information contained in the Assessor's Office files or by questioning building owners, managers or leasing agents. Off-street parking availability was determined from a City Planning Department map.

In Walnut Creek, virtually all office construction has occurred since 1965 and a significant percentage of the office buildings located near the BART station have been built since BART began operations. In order to obtain sufficient data for a meaningful comparison of offices near BART versus offices further away, rental data was sought for all office buildings with competitive space (as opposed to office buildings that are completely owner occupied), whether or not they were built before BART began operation.

Much of the office rental information obtained for the Walnut Creek area came from William Nork, leasing agent for Coldwell Banker.[10] Individual building owners, managers and agents were contacted in cases where additional informa-

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8. The following persons were particularly helpful in sharing rental information for multiple buildings: Carol Gilbert, leasing agent, Grubb & Ellis; leasing agent (source wishes to remain anonymous), Ritchie & Ritchie; John Johnston, leasing agent, Cushman and Wakefield; Jim MacDonald, Property Management Section, Coldwell Banker; Alan McGiver, Milton Meyer; Scott Patton, leasing agent, Norris, Beggs and Simpson; Steve Shain, leasing agent, Arthur Rubloff & Company.

9. Donald Clemons, BART-II, Data Documentation for the Land Use and Investment Study, Appendix C (Berkeley: BART Impact Program, 1973).

10. Other persons who provided office rental information for this study included: Jay de Leau, Walnut Creek Chamber of Commerce; John Grobe, President, John Grobe Company; Robert P. Marshall, leasing agent, Cushman and Wakefield; John Montgomery, leasing agent, Parker-Ritchie Management; John Sullivan, President, Pacific Properties; Jeff Weil, leasing agent, Grubb and Ellis.

tion was needed. A report prepared for the Walnut Creek Community Development Department in 1974, entitled "Redevelopment Potential in the Walnut Creek Core Area," also contained some office rental information.

Tenant size was obtained from Mr. Nork. Information on the class-of-construction, the gross floor area, and the year the buildings were built was generally available from the building permits for the offices. Parking availability was determined through information contained on the building permits, from a map of off-street parking in the Walnut Creek Core Area available at the Community Development Department, or by on-site inspection. Information on building height, in stories, was determined by on-site inspection.

COMMERCIAL SALES

Data on commercial sales were collected for properties in the Mission District to assess whether BART has affected the selling price of commercial property. Similar studies planned for downtown San Francisco and Oakland were redirected into studies of BART's effects on office rental rates because commercial properties tend to be sold relatively infrequently, making it difficult to obtain a sufficiently large sample.

In the Mission, data were sought for properties that had at least one sale in two of the three time periods of interest: pre-BART construction (1960-1966), the BART construction period (1967-1971), and post-BART construction. Sales records made available by the San Francisco Assessor's office were examined for every commercial property in a 103 block area surrounding the BART stations at 16th Street and Mission and at 24th Street and Mission. Only thirty cases of sales in two different time periods were found.[11]

Of these thirty properties, 53 percent contain stores, 20 percent contain offices, 17 percent are auto-related uses, 17 percent contain restaurants or bars, 10 percent contain hotels, and 7 percent are vacant or are used for storage purposes.[12] To account for non-BART factors that could have influenced the rate of change in sales prices of these properties, data were also collected on the age of the buildings sold, the size of the buildings in square feet, the distance of the properties from Mission Boulevard, the class description of the buildings, the distance of the buildings from a freeway and from freeway access, and the number of off-street parking spaces available at each location. This information was available either at the Assessor's Office or on ordinary street maps.

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11. Buildings where the ground floor is used for commercial space and the upper floors for residential units were largely excluded from the analysis because it was felt the sales price of such buildings typically reflected the value of the residential units as much as or more than they reflected the value of the commercial space.

12. Results total over 100 percent because some parcels contained more than one type of business.

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